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INTRODUCTION TO INFORMATICS

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INTRODUCTION TO INFORMATICS

Wrap-up Material	
Units Borrowed from	**Unit No.**
Old book of Geoinformatics MGIS-01, UOU	1,3,4,10
Computer Science book UOU, CCA-01, CCA-02	2, 5, 6, 7, 8, 9

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1.1 OBJECTIVES

After reading this unit you will be able to:

- Understand about application of Information Technology.
- Gain knowledge about number system.
- Explain about Error Detection code.
- Understand about Memory Representation.

1.2 INTRODUCTION

Computer is the most powerful tool man has ever created. Computers have made a great impact on our everyday life. Today, computer technology has permeated every sphere of existence of modern human being. With the growing information needs the computer has become one of the vital components for the survival of the business houses.

Information technology (IT) is the acquisition, processing, storage and dissemination of vocal, pictorial, textual and numerical information by a microelectronics-based combination of computing and telecommunications. It is the use of computers and software to manage information related to any organization or entity.

1.3 APPLICATION OF INFORMATION TECHNOLOGY

Now a day computer is being used almost in every aspects of life. Every company, small or large, government offices, educational institutions are now directly or indirectly dependent on computers mainly for information processing. Computer based railway and airway reservation system is a common example of computer application. Computer system is helping in the efficient management of the banking sector, hospital records, and payroll records and so on. Some of the areas where computers are being used mostly can be listed as below:

Science:

Scientists are using computers to carry out their research works based on complex computations because of computer's fast speed and the accuracy.

Education:

In schools and colleges, to make education much more interesting, computers are used now days. Computer   Aided Education (CAE) and Computer Based Training (CBT) packages are making learning much more interactive.

Health and Medicine:

Starting from diagnosing the illness to monitoring a patient's status during a surgery , in pathological analysis ,in CAT scans or MRI scans etc. , doctors are using computers. Some special purpose computers are available which can even be operated within the human body.

Engineering:

Engineers and architects are using computers in designing machineries, drawing design layouts. Architects can object that can be viewed from all the three dimensions by using techniques like virtual reality. In manufacturing industries, using computerized robotic arms hazardous jobs can be performed. The packages like Computer Aided Designing (CAD),

Computer Aided Manufacturing (CAM) and so on are used in designing the product, ordering the parts and planning production.

Entertainment:

With the use of multimedia facilities, computers are now greatly used in entertainment industry. Computers are used to control and bring special effects on image and sound.

Communication:

Computer network and finally the Internet has brought a drastic change in communication system. Through E-mail or Electronic mail, it is possible to send messages and reports very fast from one person to another or a group of   persons with the aid of computers and telephone lines.

Business and Banking

In business sectors, currently computers are used for real time applications such as sales counter, on line booking etc. Other applications are business forecasting, order report generation, pay bill generation, personal record keeping and so on. In the field of banking and finance also computers have many applications.

1.4 NUMBER SYSTEM

We are familiar with the decimal number system which is used in our day-to-day work. Ten digits are used to four decimal numbers. To represent these decimal digits, ten separate symbols 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 are used. But a digital computer stores, understands and manipulates information composed of any zeros and ones. So, each decimal digit, letters, symbols etc. written by the programmer (an user) are converted to binary codes in the form of 0's and 1's within the computer. The no. system is divided into some categories according to the base (or radix) of the system as binary octal and hexadecimal. If a number system of base r is a system, then the system has r distinct symbols for r digits. The knowledge of the number system is essential to understand the operation of a computer.

1.4.1 Decimal Number System

Decimal no. system have ten digits represented by 0,1,2,3,4,5,6,7,8 and 9. So, the base or radix of such system is 10.

In this system the successive position to the left of the decimal point represent units, tens, hundreds, thousands etc. For example, if we consider a decimal number 257, then the digit representations are

	2	5	7
	Hundred	Tens	Units
	Position	Position	Position

The weight of each digit of a number depends on its relative position within the number.

Example 1.1:

The weight of each digit of the decimal no. 6472

6472   =   6000+400+70+2

= $6 \times 10^3 + 4 \times 10^2 + 7 \times 10^1 + 2 \times 10^0$

The weight of digits from right hand side are-

Weight of 1st digit $= 2 \times 10^0$

Weight of 2nd digit $= 7 \times 10^1$

Weight of 3rd digit $= 4 \times 10^2$

Weight of 4th digit $= 6 \times 10^3$

The above expressions can be written in general forms as the weight of nth digit of the number from the right hand side

$= n^{th}$ digit $\times 10^{n-1}$

$= n^{th}$ digit $\times$ (base)$^{n-1}$

The no. system in which the weight of each digit depends on its relative position within the number is called positional number system. The above form of general expression is true only for positional number system.

1.4.2 Binary Number System

Only two digits 0 and 1 are used to represent a binary number system. So the base or radix of binary system is two (2). The digits 0 and 1 are called bits (Binary Digits). In this number system the value of the digit will be two times greater than its predecessor. Thus the value of the places are-

<-- <-- 32 <-- 16 <--8 <--4 <--2 <--1

The weight of each binary bit depends on its relative position within the number. It is explained by the following example--

Example:

The weight of bits of the binary number 10110 is-

$= 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0$

$= 16 + 0 + 4 + 2 + 0 = 22$(decimal number)

The weight of each bit of a binary no. depends on its relative pointer within the no. and explained from right hand side

Weight of 1st bit $=$ 1st bit $\times 2^0$

Weight of 2nd bit $=$ 2nd bit $\times 2^1$

....

....

and so on.

The weight of the nth bit of the number from right hand side

$= n^{th}$ bit $\times 2^{n-1}$

$= n^{th}$ bit $\times$ (Base)$^{n-1}$

It is seen that this rule for a binary number is same as that for a decimal number system. The above rule holds good for any other positioned number system. The weight of a digit in any positioned number system depends on its relative positon within the number and the base of the number system.

Table 1.1 shows the binary equivalent numbers for decimal digits .

Table: Binary equivalent of decimal numbers

Decimal Number	Equivalent Binary Number
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001

1.4.3 Octal Number System

A commonly used positional number system is the Octal Number System. This system has eight (8) digit representations as 0,1,2,3,4,5,6 and 7. The base or radix of this system is 8. The values increase from left to right as 1, 8, 64, 512, 4096 etc. The decimal value 8 is represented in octal as 10, 9 as 11, 10 as 12 and so on. As $8=2^3$, an octal number is represented by a group of three binary bits. For example 3 is represented as 011, 4 as 100 etc.

Table: The octal number and their binary representations.

Decimal Number	Octal Number	Binary Coded Octal No.
0	0	000
1	1	001
2	2	010
3	3	011
4	4	100
5	5	101
6	6	110
7	7	111
8	10	100 000
10	12	001 010
15	17	001 111
16	20	010 000

1.4.4 Hexadecimal Number System

The hexadecimal number system is now extensively used in computer industry. Its base (or radix) is 16, ie. 0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F. The hexadecimal numbers are used to represent binary numbers because of case of conversion and compactness. As $16=2^4$, hexadecimal number is represented by a group of four binary bits. For example, 5 is

represented by 0101. Table 2.3 shows the binary equivalent of a decimal number and its hexadecimal representation.

Table: Hexadecimal number and their Binary representation

Decimal No.	Hexadecimal No.	Binary coded Hex. No
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

1.5 NUMBER SYSTEM CONVERSION

As the computer uses different number systems, there is a process of converting generally used decimal number systems to other number systems and vice-versa.

1.5.1 Binary to Decimal Conversion

To convert a binary number to its decimal equivalent we use the following expression.The weight of the nth bit of the number from right hand side

$$= n^{th} \text{ bit X } 2^{n-1}$$

First we mark the bit position and then we give the weight of each bit of the number depending on its position. The sum of the weight of all bits gives the equivalent number.

Example: Convert binary $(110100)_2$ to its decimal equivalent

Solution:

$$(110100)_2 = 1 \times 2^5 + 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 0 \times 2^0$$
$$= 32 + 16 + 0 + 4 + 0 + 0$$
$$= (52)_{10}$$
$$(110100)_2 = (52)_{10}$$

Example: Converting binary fraction $(111011.101)_2$ to its equivalent decimal fraction.

Solution:

$(111011.101)_2 = (1 \text{X} 2^5 + 1 \text{X} 2^4 + 1 \text{X} 2^3 + 0 \text{X} 2^2 + 1 \text{X} 2^1 + 1 \text{X} 2^0) + (1 \text{X } 2^{-1} + 0 \text{X} 2^{-2} + 1 \text{X} 2^{-3})$

$\qquad\qquad = (32 + 16 + 8 + 0 + 2 + 1) + (0.5 + 0 + 0.125)$

$\qquad\qquad = (59.625)_{10}$

$\qquad (111011.101)_2 = (59.625)_{10}$

1.5.2 Decimal to Binary Conversion

There are different methods used to convert decimal number to binary number. The most common method is, *repeated-division* method. In this method, the number is successively divided by 2 and its remainders 0's abd 1's are recorded. The final binary result is obtained by assembling the remainders in reverse order to obtain the binary equivalent of the decimal number. In this case, the last remainder will be the most significant bit (MSB).

Example 1.5 Convert $(75)_{10}$ to its binary equivalent

	Remainder	
2 |75		
2|37	1	
2|18	1	
2|9	0	Read in
2|4	1	reverse order
2|2	0	
1	0	

So, $(75)_{10} = (1001011)_2$

The method to convert the fraction decimal number to its binary equivalent, is repeatedly multiply the fraction part by 2 and count the most significant bits in the order they appear.

Example: Convert decimal fraction $(12.75)_{10}$ to its equivalent binary fraction.

	Remainder	MSB	.75	
2|12			X 2	
2|6	0		1.50	Read
2|3	0		X 2	the MSB
1	1		1.00	bits.

So, $(12)_{10} = (1100)_2$ and $(.75)_{10} = (.11)_2$

Now, $(12.75)_{10} = (1100.11)_2$

1.5.3 Octal to Decimal Conversion

The method of converting octal numbers to decimal numbers is simple. The decimal equivalent of an octal number is the sum of the numbers multiplied by their corresponding weights.

Example: Find decimal equivalent of octal number $(153)_8$

Solution: $1 \text{X} 8^2 + 1 \text{X} 8^1 + 1 \text{X} 8^0 = 64 + 40 + 3 = 107$

$\qquad$ So, $(153)_8 = (107)_{10}$

Example: Find decimal equivalent of octal number $(123.21)_8$

Solution: $(1 \text{X} 8^2 + 2 \text{X} 8^1 + 3 \text{X} 8^0) + (2 \text{X} 8^{-1} + 1 \text{X} 8^{-2})$

$= (64 + 16 + 3) + (0.25 + 0.0156) = 83.2656$

So, $(123.21)_8 = (83.2656)_{10}$

1.5.4 Decimal to Octal Conversion

The procedure for conversion of decimal numbers to octal numbers is exactly similar to the conversion of decimal number to binary numbers except replacing 2 by 8.

Example: Find the octal equivalent of decimal $(3229)_{10}$

Solution: Remainders

   8 | 3229

    8 | 403   5   read in

     8 | 50   3   reverse

      8 | 6   2   order

       0   6

So, $(3229)_{10} = (6235)_8$

Example: Find the octal equivalent of $(.123)_{10}$

Solution: Octal equivalent of fractional part of a decimal number as follows:

   8 X 0.123 = 0.984   0

   8 X 0.984 = 7.872   7   read in

   8 X 0.872 = 6.976   6   forward order

   8 X 0.976 = 7.808   7

Read the integer to the left of the decimal point

The calculation can be terminated after a few steps if the fractional part does not become zero.

The octal equivalent of

$$(0.123)_{10} = (0.0767)_8$$

1.5.5 Hexadecimal to Decimal Conversion

The method of converting hexadecimal numbers to decimal number is simple. The decimal equivalent of an hexadecimal number is the sum of the numbers multiplied by their corresponding weights.

Example: Find the decimal equivalent of $(4A83)_{16}$

Solution:

   $(4A83)_{16} = (4 \text{ X } 16^3) + (10 \text{ X } 16^2) + (8 \text{ X } 19^{1)}) + (3 \text{ X } 16^0)$

    $= 16384 + 2560 + 128 + 3$

    $= (19075)_{10}$

   $(4A83)_{16} = (19075)_{10}$

Example: Find the decimal equivalent of $(53A.0B4)_{16}$

Solution:

$(53A.0B4)16 = (5 \times 16^2) + (3 \times 16^1) + (10 \times 16^0) + (0 \times 16^{-1}) + (11 \times 16^{-2}) + (4 \times 16^{-3})$

$$=1280+48+10+0+0.04927+0.0009765$$

$$=(1338.0439)_{10}$$

$(53A.0B4)_{16} = (1338.0439)_{10}$

1.5.6 Decimal to Hexadecimal Conversion

To convert a decimal integer number to hexadecimal, successively divide the given decimal number by 16 till the quotient is zero. The last remainder is the MSB (Most Significant Bit). The remainders read from bottom to top give the equivalent hexadecimal integer.

To convert a decimal fraction to hexadecimal, successively multiply the given decimal fraction by 16, till the product is zero or till the required accuracy is obtained, and collect all the integers to the left of decimal point. The first integer is the MSB and the integers read from top to bottom give the hexadecimal fraction.

Example: Convert decimal $(1234.675)_{10}$ to hexadecimal.

Solution:

1st consider $(1234)_{10}$

	Remainder	
	Decimal	Hexadecimal
16	1234	2	2
		read in
16|77	13	D reverse
		order
16	4	4	4

$(1234)_{10} = (4D2)_{16}$

Conversion of $(0.675)_{10}$

Hexadecimal conversion of fractional part of a decimal number as follows:

	Decimal	Hexadecimal
0.675 X 16 = 10.8	10	A
0.800 X 16 = 12.8	12	C
0.800 X 16 = 12.8	12	C
0.800 X 16 = 12.8	12	C

$(0.675)_{10} = (0.ACCC)_{16}$

Hence, $(1234.675)_{10} = (4D2.ACCC)_{16}$

If the decimal number is very large, it is tedious to convert the number to binary directly. So it is always advisable to convert the number into hex first, and then convert the hex to binary.

1.6 ERROR DETECTION CODE

The error detection and correction is to add some redundancy (i.e., some extra data) to a message, which receivers can use to check consistency of the delivered message, and to recover data determined to be erroneous.

In Error-detection and correction schemes the transmitter sends the original data, and attaches a fixed number of check bits (or parity data), which are derived from the data bits by some deterministic algorithm. If only error detection is required, a receiver can simply apply the same algorithm to the received data bits and compare its output with the received check bits; if the values do not match, an error has occurred at some point during the transmission.

Some of the error detection schemes are as follows:

Repetition codes

A repetition code is a coding scheme that repeats the bits across a channel to achieve error-free communication. Given a stream of data to be transmitted, the data is divided into blocks of bits. Each block is transmitted some predetermined number of times. For example, to send the bit pattern "1011", the four-bit block can be repeated three times, thus producing "1011 1011 1011". However, if this twelve-bit pattern was received as "1010 1011 1011" – where the first block is unlike the other two – it can be determined that an error has occurred.

Repetition codes are very inefficient, and can be susceptible to problems if the error occurs in exactly the same place for each group (e.g., "1010 1010 1010" in the previous example would be detected as correct). The advantage of repetition codes is that they are extremely simple, and are in fact used in some transmissions of numbers stations.

Parity bit

A parity bit is a bit that is added to a group of source bits to ensure that the number of set bits (i.e., bits with value 1) in the outcome is even or odd. It is a very simple scheme that can be used to detect single or any other odd number (i.e., three, five, etc.) of errors in the output. An even number of flipped bits will make the parity bit appear correct even though the data is erroneous.

1.7 MEMORY REPRESENTATION

You will be strange that - the computer is made up with millions of tiny electric circuits that are not visible to us. The memory elements are also building with this tiny circuitry which is used for storing data. How the data are stored in that electronic circuit? To better understand how a computer stores information let's take a closer look. For every circuit in a computer chip, there are two possibilities:

·An electric current flows through the circuit or

·An electric current does not flow through the circuit.

When an electric current flows through a circuit, the circuit is on. When no electricity flows, the circuit is off. An "on" circuit is represented by the number one (1) and an off circuit is represented by the number zero (0). The number 1 or 0 is called **bit**. The word bit comes from "binary digit". Each time a computer reads an instruction, it translates that instruction into a series of bits, 1's and 0's. On most computers every character from the keyboard is

translated into eight bits, a combination of eight 1's and 0's. Each group of 8 bits is called 1 byte as shown in the following figure. Each group of four bits is called a nibble.
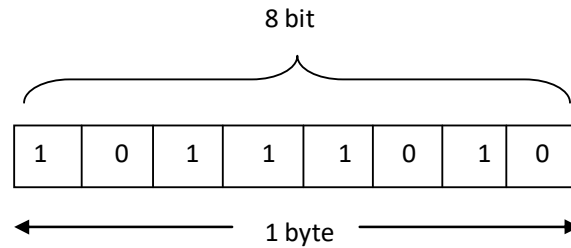
8 bit

| 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |

1 byte

Figure 1.1 Representation of 1-byte

Thus, 8 bits = 1 byte

         4 bits = 1 nibble and

         1024 byte = 1 kilo byte

We know that, all the quantities, physical or abstract, can be measured in some units. For example, time is measured in second; length is measured in meters and mass in grams. Similarly, the computer memory can be measured in terms of bits, bytes, kilobytes, megabytes, gigabytes etc.

The followings are the measuring units given in terms of bytes :

1 kilobyte (KB) = 1,024 byte

1 megabyte (MB) = 1,048,576 bytes

1 gigabyte (GB) = 1,073,741,824 bytes

1 terabyte = 1,099,511,627,776

1.8 PRIMARY MEMORY

The term *memory* usually refers to a form of semiconductor storage and sometimes other forms of fast but temporary storage. Similarly, today the term *storage* more commonly refers to mass storage such as optical discs, forms of magnetic storage like hard disks and other types. All these are slower than memory, but of a more permanent nature. Generally , the computer memory is divided into two category : **primary memory** and **secondary memory**. The term primary memory is used to represent the *memory* and the term secondary memory is used to represent the *storage.*

Primary memory is directly accessible to the CPU. The CPU continuously reads instructions stored there and executes them. Any data actively operated on is also stored there in uniform manner. It is a form of semiconductor storage known as random access memory (**RAM**) and sometimes other forms of fast but temporary storage. It is small-sized, light, but quite expensive. This type of memory is divided into the following two types :

a)RAM (Random Accress Memory)

b)ROM (Read Only Memory)

1.8.1 Random Access Memory (RAM)

A computer's **main memory** is often referred to as RAM - an area in the computer system unit that temporarily holds user data, operating system instructions and program instructions.

Every time we turn on our computer, a set of operating system instructions is copied from hard disk into RAM. These instructions, which help control basic computer functions, remain in RAM until we turn the computer off.

RAM features:

a)   RAM is the place which holds the data that has to be processed by the computer's preocessor. Moreover, it hold the operating system and other application programs also.

b)   RAM is made up of different ICs (Integreted Circuits). They are also called *semiconductor memory*.

c)   Each element of RAM is a memory location in which data can be stored. Each location has a **unique address**. Using this address data can be directly retrieved or stored.

d)   Since RAM must hold both the data to be processed and the instructions for processing, its size or capacity is one of the measure of power of the computer.

e)   RAM is a volatile memory and loss its data when the computer turned off.

There are generally two broad categories of random access memory :

i)DRAM memories (*Dynamic Random Access Memory*)

ii)SRAM memories (*Static Random Access Memory*)

DRAM :

Dynamic RAM is a type of RAM in which data is stored in a storage cell, consisting of transistors and capacitors. A common property of a capacitor is its tendency to get discharge, it means the current goes down in the circuit and finally data cannot holds for long time. To overcome this effect, the DRAM needs to be continuously refreshed with power supply and thus it has one *refreshing circuit* which r-writes the data in certain time intervals. This refreshing circuit refreshes or rewrites the data several hundred times in a second.

SRAM :

Static RAM is a type of RAM that holds its data as long as power is supplied to the circuit.

The SRAM does not need any refreshing circuit. SRAMs are used for specific applications within the PC. The SRAM has the following properties :

·   **Simplicity :** SRAMs don't require external refresh circuitry in order for them to keep their data intact.

·   **Speed :** SRAM is faster than DRAM.

In contrast, SRAMs have the following weaknesses, compared to DRAMs:

·   **Cost :** SRAM is more expensive than DRAM.

·   **Size :** SRAMs take up much more space than DRAMs

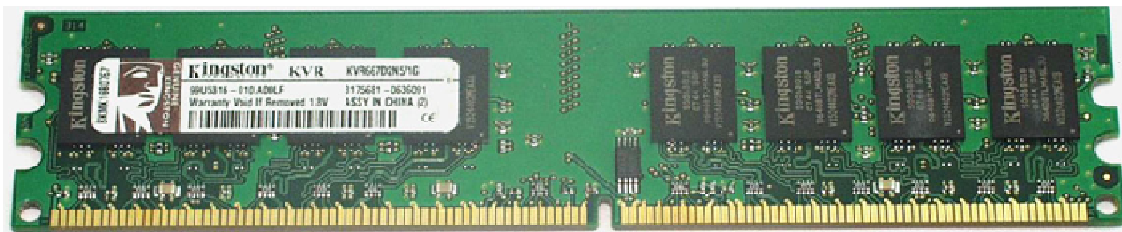The physical image of a RAM chip is shown in the following figure :

Figure 1.2 A RAM chip

1.8.2 Read Only Memory

One major type of memory that is used in PCs is called *read-only memory*, (*ROM*). ROM is the memory that stores the data permanently i.e. the instructions in ROM are permanent whether the power is on or off. We have no way to change them, unless we remove the ROM chips from the main board and replace them with another set.

Read-only memory is most commonly used to store system-level programs that we want to have available to the PC at all times. For example, the ROM-BIOS (ROM basic input and output services) programs are stored in ROM chips which are used to boot up (start up) the computer.

The following are the different types of ROMs with a description of their relative modifiability:

Programmable ROM (PROM) : This is a type of ROM that can be programmed using special equipment; it can be written to, but only once.

Erasable Programmable ROM (EPROM) : An *EPROM* is a ROM that can be erased and reprogrammed. Ultraviolet light of a specific frequency is used for erasing the EPROM and allow it to be reprogrammed again.

Electrically Erasable Programmable ROM (EEPROM) : The next level of erasability is the *EEPROM*, which can be erased under software control. This is the most flexible type of ROM, and is now commonly used for holding BIOS programs.

Another one important types of memory used in a computers are– the ***cache memory and registers***.

Cache memory:

Cache memory is a special type of RAM (static RAM) which is the faster memory used in a computer system in between the CPU and main memory. It means that the accessing speed from the cache memory is faster than the main memory used in computer. So, the use of the cache memory reduces the average access time and helps the processor for fast processing. The Cache memory stores the instructions and data that are frequently needed by the processor for execution. Cache memory chip is a static memory chip. It is much expensive than the main memory. Cache size varies from 32 MB to 128MB or 512MB etc.

Registers:

Registers are the small amount of storage available on the CPU whose contents can be accessed more quickly than any other storage available in a computer system. Registers are the fastest memory element and thus provide the fastest way for a CPU to access data. Registers are normally measured by the number of bits they can hold, for example, an "8-bit register" or a "32-bit register". Registers can be classified as general purpose registers and special purpose registers.

1.9 SECONDARY MEMORY

Secondary memory or *storage* provides the facility of storing information and programs permanently. It differs from primary memory in that it is not directly accessible by the CPU. The computer usually uses its input/output channels to access secondary storage and transfers desired data using intermediate area in primary memory. Secondary storage does not lose the

data when the device is kept out of power. It is non-volatile. It is less expensive than primary memory.

In modern computers, hard disks are usually used as secondary storage.   Some other examples of secondary storage devices are: optical disk, floppy disks, magnetic tape, Paper tape, Punch Cards, standalone RAM disks, flash memory (e.g. USB sticks or keys), and Zip drives etc.

1.9.1 Magnetic Tape

Magnetic tapes are the plastic tapes with magnetic coating that are used for storing the data, such as text, audio or video. Magnetic tapes are similar to the normal recording tapes, which are used for audio and video recording. Magnetic tape is a medium for magnetic recording, made of a thin magnetizable coating on a long, narrow strip of plastic. A device that stores computer data on magnetic tape is called a tape drive. The data stored on the magnetic tapes can be accessed using the sequential access method. A magnetic tape is show:

Figure 1.3 A magnetic tape

Major advantages of magnetic tapes are:
•   Low cost
•   Large storage capacity
•   Easily transportable
•   Easy to handle and store

1.9.2 Magnetic Disks

Magnetic disks are widely used popular secondary storage medium. A magnetic disk consists of plastic or metal circular plate or platter. These platters are coated with magnetic oxide layer. The data stored in magnetic disks can be accessed directly. They provide high storage capacity and reliability. Data is represented as magnetized spots on a disk .The presence of a spot represents a 1 and the absence of a magnetized spot represents a 0. The information is accessed using one or more read/write **heads**.

A magnetic disk typically contains several rotating disks, or platters. There is one head for each surface, and all the heads move together. The disk rotates at around 3600 rpm (rotation per minutes) with the heads floating microscopic distances above the surfaces. Data on the magnetic disks is organized in a concentric set of circles, called **tracks**. Each track is divided into **sectors**. The following diagram shows the tracks and sectors of a platter.

We have already mentioned that magnetic disk uses a single read/ write head for each disk surface. The read/write head may be movable or fixed. The following figure shows a movable read/ write heads for each surface:

There are two popular types of magnetic disks:
•   Hard disks
•   Floppy disks

Major advantages of magnetic disks are:
•   High storage capacity
•   Easy, direct access to data
•   Easily moveable from one place to another
•   Better data transfer rate as compared to magnetic tapes
•   Low cost compared to RAM
•   Less prone to corruption of data as compared to tapes

1.9.3 Optical Media

The optical media are used for the same purpose as the magnetic storage system. We have already found that in case of magnetic media there is a coating of magnetic material on the surface of the medium. But in case of optical medium laser light is used to retrieve as well as record data. Examples of optical storage mediums are given below:
•   Compact Disk - Read only memory (CD-ROM)
•   Digital Video Disk (DVD)
•   Compact Disk - Recordable (CD-R)
•   Compact Disk - Rewritable (CD-RW)
•   Digital Video Disk - Recordable (DVD-R)
•   Digital Video Disk - Rewritable (DVD-RW)

Like other storage media, optical storage are non-volatile in nature and also they are more reliable as compared to the magnetic medium.

CD-ROM:

We are already familiar with CD-ROM disk is a shiny, silver color metal disk usually of12cm diameter. It is made of polycarbonate plastic and thin layer of pure aluminum is applied to make the surface reflective. For some good quality disks, gold layer is used. A thin layer of lacquer protects it. The surface of an optical disk consists of *pits* and *land*. The information is read from pits and lands, like 1s and 0s. It is changed into binary so computers can read it. An optical reader reads the patterns of pits that stands for bytes. One CD can hold 650MB of data or 300,000 pages of text. Most CDs are read only, which means you cannot save data to the disk. This device is usually not used as a primary storage device for data.

An optical disk is mounted on an optical disk drive for reading/writing of information on it. An optical disk drive contains all the mechanical, electrical and electronic components for holding an optical disk and for reading/writing of information on it. That is, it contains the tray on which the disk is kept, read/write **laser beams assembly**, and the motor to rotate the disk. Access time for optical disks are in the range of 100 to 300 milliseconds.

Advantages of CD-ROM are –
a)   Storage capacity is much more in optical disks.

b)   Multiple copies of the disk along with its contents can be made inexpensively.

c)   They are transportable from one computer to another very easily.

DVD Disks:

The success of CD technology and the continuing quest for greater storage capability has led to the development of DVD. **DVD**, also known as **Digital Versatile Disk** or **Digital Video Disk**, is an optical disk storage media format, and was invented and developed by Sony and Philips in 1995. Its main uses are video and data storage. DVDs are of the same size as compact disks (CDs), but can store more than six times of data as that of a CD.

Variations of the term *DVD* often indicate the way data is stored on the disks : DVD-ROM (read only memory) has data that can only be read and not written; DVD-R and DVD+R (recordable) can record data only once, and then function as a DVD-ROM; DVD-RW (re-writable), DVD+RW, and DVD-RAM (random access memory) can all record and erase data multiple times.

RAID TECHNOLOGY: RAID technology was first defined by a group of computer scientists at the University of California at Berkeley in 1987. The scientists studied the possibility of using two or more disks to appear as a single device to the host system. RAID is a method of combining several hard disk drives into one logical unit (two or more disks grouped together to appear as a single device to the host system). RAID technology was developed to address the fault-tolerance and performance limitations of conventional disk storage. It can offer fault tolerance and higher throughput levels than a single hard drive or group of independent hard drives.

FLASH MEMORY: Flash memory is a non-volatile computer storage chip that can be electrically erased and reprogrammed. Flash drives and pen drives are USB storage devices based on flash memory. It is primarily used in memory cards, USB flash drives, MP3 players and solid-state drives for general storage and transfer of data between computers and other digital products.

1.10 SUGGESTED READINGS

1. Computer System Architecture, M.M. Mano, PHI
2. Digital logic and Computer Design, M.M. Mano, PHI
3. Computer Fundamentals Architecture and Organization, B. Ram, New Age International (P) Ltd.
4. Digital Techniques, P.H. Talukdar.

1.11 TERMINAL QUESTION

1. What is Computer Memory?
2. How Covert Binary number to Decimal Number?
3. What is the different between RAM and ROM?
4. What is Mainframe Computer?
5. What is magnetic disk and its Size?
6. What is a RAM? What are its two types? Differentiate between them.

7. What is a ROM? Why is it called so? List differenet types of ROMs and their key features.
8. What is a cache memory? How is it different from a primary memory?
9. Differentiate between
a. PROM and EPROM.
b. Static RAM and Dynamic RAM
10. Write down the difference between a magnetic tape and a magnetic disk.
11. Write short note :
a. Primary memory
b. Secondary memory
c. Magnetic tape
d. Magnetic disk
e. Compact disk

UNIT 2: COMMUNICATION AND CONNECTIVITY

2.1 LEARNING OBJECTIVES

At the end of this unit, you should be able to:
1. Describe the various uses of telecommunications.
2. Evaluate the different communication media.
3. Define a network.
4. Describe and illustrate the various types of networks.
5. Describe types of networks.

2.2 INTRODUCTION

This unit is an interesting, but technical one where the discussion expands to the connection of more than one computer to meet various needs. It also discusses how these computers can be connected and the accompanying reasons or purpose for their connections. The popular topic of the Internet is also introduced with its intriguing services and benefits, and the different methods of connecting to the world wide web.

Computers are linked together to exchange data and share resources as said to be networked. Networks allow users communicate with others once there is access to a computer. Networks come in a variety of forms and support a variety of different asynchronous and synchronous communications methods.

2.3 COMMUNICATIONS

In our day to day lives we regular communicate with others through talking, writing, and actions. Computer networks communicate by first becoming linked to each other, so that data and resources can be shared. For example, two or more computers can be connected to each other, along with one printer (a resource), so that each computer is able to print form this one printer. This is known as a simple network and you are sharing output devices via the network.

Computer communication is achieved when signals are sent and received among and between different computers. This exchange of signals allows users to collaborate with other online users in different countries. Individuals can share and retrieve information and files they can exchange electronic mail and participate in electronic messaging with others from all over the world.

2.3.1 Collaboration and Sharing

Computer communication has provided contact among users from different cultures, continents, and time zones. Indeed, *telecommunications* technologies such as land lines, satellite, cable, the Internet and cell phone technology have made communication possible and affordable over long distances. Many business organizations and individuals have taken advantage of *teleconferencing* and *videoconferencing* – conferencing available on the Internet, and through you telephone, cable and satellite providers. Today people do not have to travel for meetings or conferences. Telecommunications technologies allow employees to work from home, or away from the office, while still interact with the others in the company through computer communications. They are able to send and receive documents, share schedules, send messages

and talk directly with their co-workers. This 'work away from the office, is known as *telecommuting*.

2.4 TRANSACTION PROCESSING

In previous years data and information were stored in a central location, and many users would simultaneously access this single location to retrieve data required for a transaction, or other reasons. This caused problems, as not everyone was able to access data in a timely fashion. Large numbers of requests to a central processor or storage location takes time taken to send and retrieve the large or small amounts of data or information. The volume of data moving through the system often slowed the system down and at times even crashed or shut down the system. With computer communication systems now available, data and information (and indeed the workload) can now be dispersed (or distributed) to various sites, subsidiaries or branches of the business in other areas of the building or country.

Indeed many large corporations link some parts of their systems with the systems of their major customers. This inter-organizational system link also allows the corporation's systems to link to suppliers for electronic data interchange (EDI). This facilitates speedy order processing and other transaction processing.

2.5 INFORMATION RETRIEVAL

Information retrieval is important for decision making in business, industry, research organizations, and even for entertainment. Various types of information (such as music, text, sound) can now be stored in private or public databases. Once these databases are made available online, they can be accessed by select persons either through the use of the Internet, or an internal company network, called an Intranet.

2.6 ELECTRONIC MAIL AND ELECTRONIC MESSAGING

Electronic mail and electronic messaging are one of the most popular methods of communicating among persons of all ages. Messaging includes text messaging using cellular phones, online messaging using programs such as MSN and Google talk. Paging, sending and receiving sending faxes and the use of voice mail are also methods of electronic messaging. Electronic mail (e-mail) and online messaging also enables persons to send and receive softcopy documents as attachments.

2.7 EFFICIENT AND EFFECTIVE COMMUNICATION

In order for computer communication to be effective and efficient, many agencies must be involved. These include the telecommunications telephone, cable and satellite companies in the various countries, as well as the many Internet Service Providers who provide access to the Internet. Indeed the number of businesses that are involved in the operation and management of

Information and Communications Technologies (ICTs) include: software providers; hardware providers; custom development companies; online communications and collaboration companies; and others. Finally governments must create legislations that governs the access to data and the use of data and provides oversight of the telecommunications industry.

2.8 CONNECTING COMPUTERS

This Topic is a bit technical as it describes the media that are used to connect computers together in order to share data and peripheral devices. There are also different ways in which computers are connected and it discusses the advantages and disadvantages of each. The Topic also includes a brief discussion on the services and benefits of the Internet, and the various methods for connecting to the World Wide Web.

2.8.1 Communication System Components

Wired or wireless media are used to allow communications among computers. Wired media include twisted-pair, coaxial and fibre optic cable. Twisted-pair cable and coaxial cable transmit data by means of electric frequencies. These cables therefore need to be protected against water and electromagnetic waves. Fibre optic cable is an improvement on the previous two cables. A fibre optic cable consists of glass or plastic tubes which transmit data over longer distances at a faster speed, using reflection of light. Fibre-optic cables are more secure and much thinner and lighter than other metal wires, and they are not affected by electromagnetic noise such as radios, motors and others cables. Although fibre-optic cables are very costly and difficult to install, they are extremely popular with telephone companies, banks, and television companies replacing their existing telephone and coaxial cables with more efficient fibre-optic cables.

As the term implies, wireless media in a telecommunications network connects nodes without the use of wires. Wireless network systems incorporate cellular technology which uses satellites, radio and other signals, to allow for communication over land and sea across the world. Wireless networks are very useful in sending and sharing data quickly within small offices or among business across the world. More importantly they are relatively inexpensive in connecting to the Internet, especially in countries where there are scarce resources or poor infrastructure. Wireless networks therefore eliminate the maze of cables, while offering more mobility. However the disadvantage of wireless media is interference from other networks that might block the radio signals from passing through.

2.8.2 Network Topologies

The physical layout of a network is called a topology. The four main topologies will be discussed in this section. A network is a collection of computers which are connected together. When sketching the topology, each computer workstation, file server or other peripheral is generally called a node. A network topology therefore, is the arrangement of the network, whether physically (the actual layout including cable installation), or logically (the actual operation of

transferring data), according to the requirements of the network. This Topic will discuss four general network topologies.
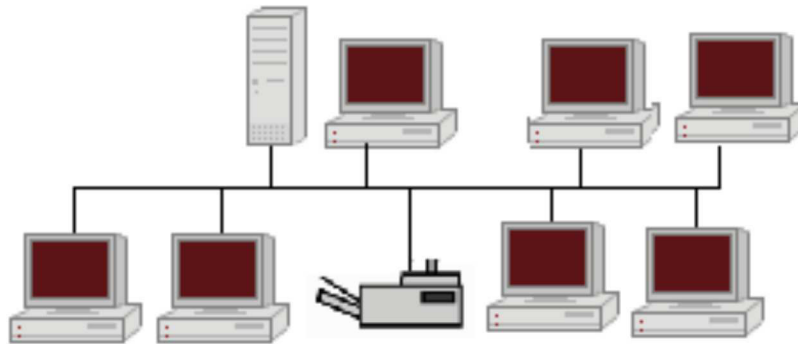
2.8.2.1 Bus Topology

Figure 1.1: Bus Topology

This linear bus topology is one of the simplest of the four network topologies to use, in its most basic form it is simply a case of running one cable called a backbone, from the computer or peripheral device at one end of the network to the last peripheral device or computer at the other end. Other computers, scanners, printers or other peripheral devices are then attached to the backbone anywhere between these two end computers.

Advantages and Disadvantages of Bus Topology

Of course from the simple description above, it seems relatively easy to connect a computer or peripheral to this topology. It also requires less lengths of cable than the other topologies, so it can be economical. Since all computers and peripherals depend on this single cable or backbone, the entire network will not work if there is a break in the backbone. This will also prove difficult to identify where the problem or break is located, if the entire network is not working. This topology is also not intended to be used as the only network arrangement where numerous computers and peripherals are to be connected. Finally it has the lowest fault tolerance, that is, a single problem in the network with a bus topology can halt all of its activities.

2.8.2.2 Star Topology
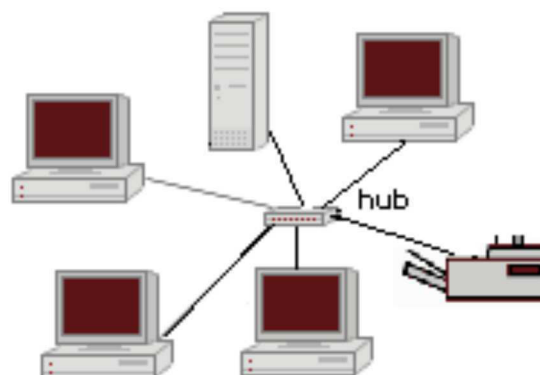
Figure 2.2: Star Topology

A star topology connects computers and peripherals to a central device called a hub. Physically the topology looks like a star. So that when a node is sending data to another node, the data passes through the hub before continuing to its destination node. The hub therefore manages and controls the network.

Advantages and Disadvantages of Star Topology

A new node is relatively easy to install by adding a cable from the new device to the hub. Installing and even removing nodes do not cause any disruptions to the network, so this topology has high fault tolerance when troubleshooting to detect faults and to remove nodes.

Of course if the hub fails, then all nodes attached to the network are disabled. It is also more expensive than the bus topology because of the cost of installing the cabling and configuring the hub.

2.8.2.3 Ring Topology
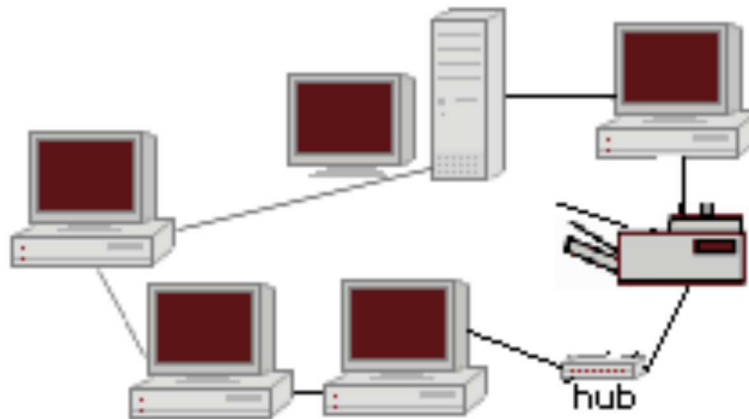
Figure 2.3: Ring Topology

The nodes in a ring topology are connected to the nodes on its left and right, so that data passes from one node to the next. Of course fault tolerance is non-existent since failure of one node cripples the entire network. This is why the physical ring topology is rarely used. Adding a new device to an existing physical Ring network can be complicated as any new device needs to go in-between the existing devices.

2.9 LOCAL AREA NETWORKS (LANS)

A Local Area Network (LAN) is a computer network that functions within a specific geographical area, such as a building, school or campus. The network links the computers located within the building. In the case of a campus, the computers are linked throughout the various buildings using wired cables or wireless communication using radio and other signals. Access to the LAN is privileged and controlled by a network administrator. Once access is authorized, users can access most of the software, data, and peripherals connected to the LAN. The main uses of LANs include the sharing of expensive devices such as printers and scanners, as well as the provision of internal Intranet and electronic-mail services. Public telephone

exchanges such as PBXs are also examples of LANs which use telephone systems in many organizations.

In order for a LAN to function, a network interface card (NIC) must be installed in the computer to provide the connection between the computer and the network. The main operating system software that supports networking are UNIX, Linux, Windows, and Mac OS. Two types of LANs are peer-to-peer and client-server, which employ a bus or ring topology.

2.9.1 Peer –to- Peer Networks

All computers on a peer-to-peer network are configured similarly with no specific computer designated as a file server. Also the users in this type of network determine which files and peripherals attached to their computer that they wish to share. This is why peer-to peer networks are simple to set-up as home businesses, and are not appropriate when there are many computers.

2.9.2 Client – Server Networks

Client-server networks can be set up using various topologies, and are appropriate in large corporations. The network requires file servers which contain the many application programs. The clients are the networked computers which access the server to obtain and use the programs, data, and to access peripherals.

2.10 METROPOLITAN AREA NETWORK (MAN)

A metropolitan area network (MAN) is a computer network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN) but smaller than the area covered by a wide area network (WAN). The term is applied to the interconnection of networks in a city into a single larger network (which may then also offer efficient connection to a wide area network). It is also used to mean the interconnection of several local area networks by bridging them with backbone lines. The latter usage is also sometimes referred to as a campus network.

2.11 WIDE AREA NETWORK (WAN)

Wide area networks (WANs) effectively connect LANs which are located at different geographical locations – a few miles or thousands of miles away. This way, a large corporation or banking institution can share, and exchange data and information, as well as perform transactions among its branches using one wide area network system.

2.11.1 Internet Services and Benefits

The Internet is a network of networks, which link local, regional, national and international computer networks to exchange data and process tasks. In order to efficiently process these tasks and exchange data, a standard called TCP/IP (Transmission Control Protocol/ Internet Protocol) comprises a set of rules which must be followed. The telecommunication links among the

networks of the Internet are built and maintained by major telecommunications companies around the world. Each computer connected to the
Internet is recognized by a unique number, officially known as an 'IP Address'. Data travels the Internet from origin computer to destination computer in small chunks called 'Packets', with the help of 'routers'.

2.11.2 Connecting to the Internet
Users can connect to the Internet through a dial-up connection or other more sophisticated connections. Irrespective of how users connect, companies called Internet Service Providers (ISP) maintain telecommunications equipment so as to provide Internet access to individual users, as well as users involved in business and large organizations. An ISP is responsible for providing each user with Internet access by connecting your computer to the Internet, much like a telephone company connects your phone to the telecommunications network.
To get access to the Internet, a user needs an optional local telephone number, a unique identification and password for access, and one or more email addresses. This is usually accompanied by a stipulated fee monthly, quarterly, yearly or simply a block of hours.

2.11.2.1 Dial-Up Internet Connection
A dial-up connection requires a device called a modem, which converts your computer's digital signals into a type of signal that can travel over phone lines. The maximum speed for dial-up is 56Kbps, or 56,000 bits per second.

2.11.2.2 Other Internet Connections
Other Internet connections provide data transfer speeds much faster than that of a dial-up connection, although they both must be in close proximate to a telephone port. An Integrated Services Digital Network (ISDN) provides data transfer speeds of 128K, while a Digital Subscriber Line (DSL) is a general name for a family of high –speed Internet links, including ADSL, SDSL, and DSL lite. These provide data transfer speeds up to 125 times faster than dialup.

2.11.3 Web Browsers
Just as you would use a software program such as a word processor, web browsers are also software programs that are also installed on your computer. Their purpose however is to allow you to access one or more web pages. In simpler terms, a web browser is just a way to help you get around the Internet, so whenever you type in an address for distance education to access your notes, for example, you are using a browser. Browsers are also useful for downloading files from databases stored on the Internet, and linking you to other pages from a main home page. Each browser keeps a list of the pages you have viewed on the Web, so that you can return to that site, even if you visited it days ago.

A typical web page contains mostly text, with some pictures, and even media such as movies or other small programs. Your browser translates the HTML language that was used to create each web page into a presentable form that users can understand. Figure shows a typical browser while Figure shows the html code that was used to create the web page.
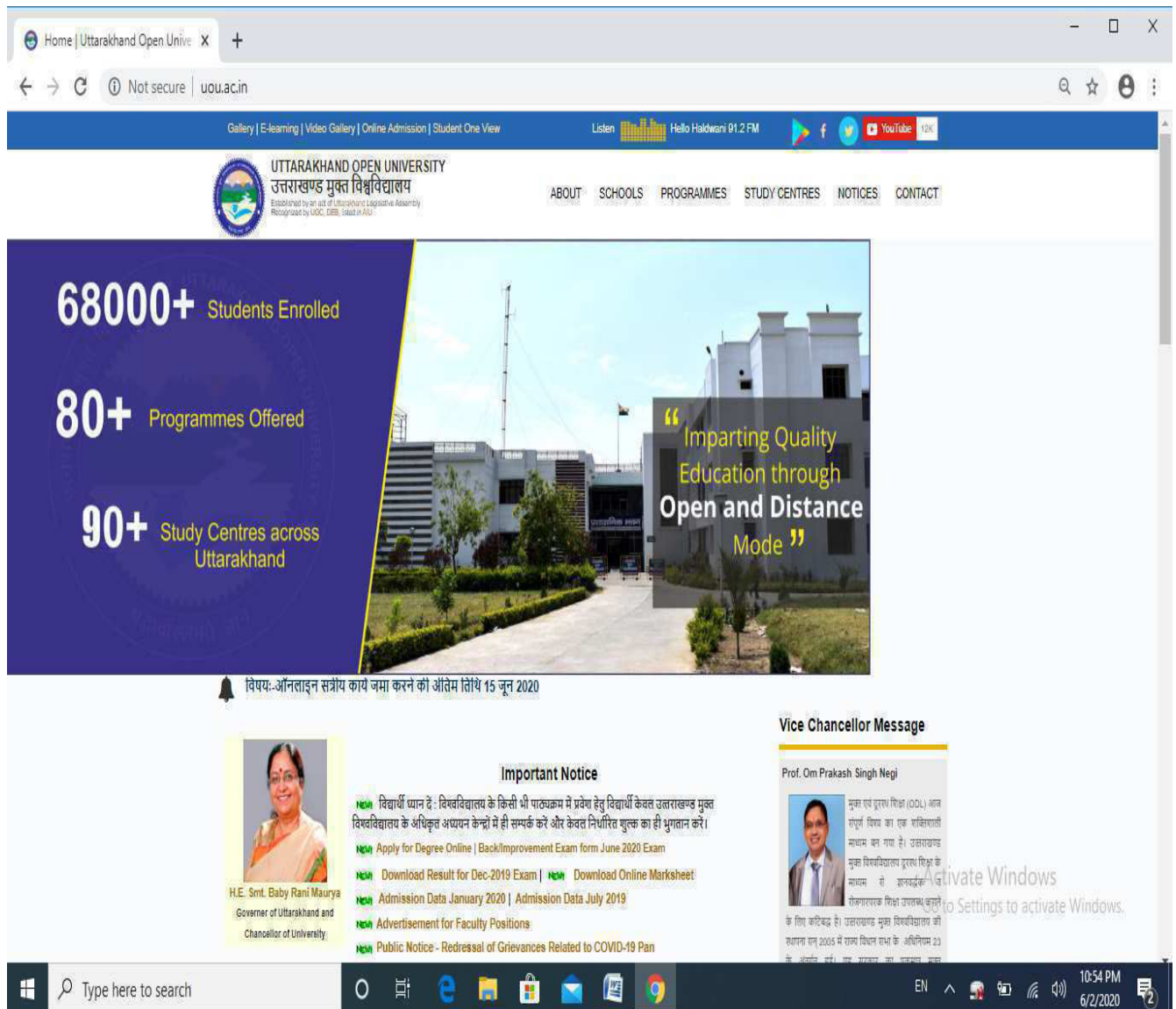

Figure 2.4: Web browser

Figure2.5: HTML Code

It is important that browsers provide efficient ways to manage bookmarks, cookies, tabbed browsing, pop-up blocker as well as have ample security options. Users may even prefer auto-fill capabilities for web-based forms.

There are many different browsers available, although the popular one is Internet Explorer (or IE). However all browsers should be able to load web pages without much difficulty and at about the same speed.

2.12 SEARCH ENGINES

Search engines access many web sites which match your request, and then show a list or sample of the web pages so that you can select those that you are interested in. generally, search engines carry out some of the following tasks. Gather a list of web pages:

- Based on a user's search for a word, phrase, web page or similar option.
- Through listing each page that contains the search word or similar words.
- If the search word is an embedded link on a web page, then the search engine peruses that link also.
- Rank the search results by web pages that contain or link to that search term most frequently.

2.12.1 Problems with Searching

Search for a word or phrase in a browser window, will produce those web pages that are relevant to what you are searching for. However, words and phrases differ in context, so you may also see other listing which do not relate to what you need. In addition, you may also see duplicate

listings since the search will list the web page with your search term, as well as all of the links from the same web page that also contain the search term.

2.12.2 World Wide Web Basic Terminology

Link	A button or interaction that allows you to navigate to related documents.
Web Page	A collection of hypertext documents and links (or hyperlinks).
Web Server	A computer that stores and distributes web pages.
Web Site	A collection of web pages with an Internet address.
HTML (Hypertext Markup Language)	A language to create web pages. The file extensions used are .htm or .html
HTTP (Hypertext Transfer Protocol)	The communications standard that is used to transport web documents over the Internet.
Hypertext	Text, video, pictures.
The Web (or World Wide Web)	A collection of files that are interconnected through of hypertext.
URL (uniform resource locator)	The internet address of a web site.

2.13 SUMMARY

The concepts in this unit include:
- Computer networks communicate by first becoming linked to each other, so that data and resources can be shared.
- Computer communication allows for collaboration among users in different countries, transaction processing, retrieval of data and information, electronic mail and electronic messaging from all over the world.
- Wired or wireless media are used to allow communications among computers.
- Wired media transmit data by means of electric frequencies.
- Wireless media connects computers without the use of wires.
- The physical layout of a network is called a topology.
- Linear bus topology is one of the simplest of the four network topologies to use.

- Star topology connects computers and peripherals to a central device called a hub.
- Ring topology are connected to the nodes on its left and right, so that data passes
- from one node to the next.
- A Local Area Network (LAN) is a computer network that functions within a specific
- geographical area, such as a building, school or campus.
- Wide area networks (WANs) connect LANs which are located at different geographical locations.
- The Internet is a network of networks, which link local, regional, national and international computer networks to exchange data and process tasks.
- Web Browsers are also software programs that are also installed on your computer.
- Search engines access many web sites which match your request, and then show a list or sample of the web pages so that you can select those that you are interested in.

In the previous units we explored the input, processing, storage and output of individual computers. This unit introduced communication among computers once they were linked together in different ways to form a network. It thus enabled the user to engage in telecommunication, teleconferencing and then telecommuting. In addition, access to data located on other computers, called servers, allowed for faster retrieval, and thus the introduction of electronic mail and electronic messaging, and the development of the Internet. Users are now able to search for any item whether it is a product, a plant or a planet!

2.14 REFERENCE

Powley, R. (2011). *Introduction to Computers*. Retrieved Sep. 21, 2017, from http://doer.col.org/bitstream/123456789/8192/1/2011_VUSSC_Intro-Computers.pdf   avaialble under CC-BY-SA license.

Wikiversity. (n.d.). *Metropolitan area network*. Retrieved Oct. 27, 2017, from https://shms.sa/courses/metropolitan-area-network   available   under   Creative   Commons Attribution-ShareAlike 4.0 International license.

License

UNIT 3: BASICS OF NETWORKING

3.1 INTRODUCTION

There has been tremendous success of World Wide Web. The merging of computers and communications has had a profound influence on the way computer systems are organized.

The concept of the "computer center" as a room with a large computer to which users bring their work for processing is now totally obsolete. The old model of a single computer serving all of the organization's computational needs has been replaced by one in which a large number of separate but interconnected computers do the job. These systems are called computer networks.

One way to categorize the different types of computer network designs is by their scope or scale. For historical reasons, the networking industry refers to nearly every type of design as some kind of *area network*. In this unit we will discuss about the different networks.

3.2 TYPES OF NETWORK

Whenever we have a set of computers or networking devices to be connected, we make the connections, depending on the physical layout and our requirements. On the basis of geographical area covered, computer networks can be classified under the following three categories:

- Local Area Network
- Metropolitan Area Network
- Wide Area Network

3.2.1   Local Area Network (LAN)

A *local area network* or **LAN**, is a high-speed data network that covers a relatively small geographic area such as a building, a laboratory, or a school. It typically connects workstations, personal computers, printers, servers, and other devices. LANs offer computer users many advantages, including shared access to devices and applications, file exchange between connected users, and communication between users via electronic mail and other applications. LANs differ in the way the computers are connected (i.e., their topology), how information moves around the network (i.e., their transmission technology) and their size.

IEEE (Institute of Electrical and Electronic Engineers) is a US publishing and standards organization responsible for many LAN standards such as the 802 series. *IEEE 802.3,* populary called *Ethernet,* is the most popular LAN, usually operating at 10 Mbps to 10 Gbps and is present in most large organizations and offices. In a typical LAN configuration, one computer is designated as the *server*. It stores all of the software that controls the network as well as the software that can be shared by the computers attached to the network. Computers connected to the server are called *workstations*. Two most commonly used LAN implementations are depicted below:
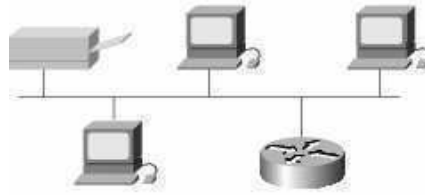
Fig. 3.1(a): Ethernet or IEEE 802.3
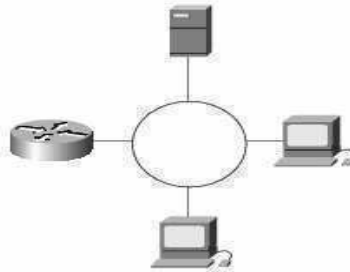
Fig. 3.1(b): Token Ring or IEEE 802.5

LAN protocols function at the lowest two layers, i.e., the *physical* and the *data link layer* of the OSI reference model. We will discuss the layer concept of ISO-OSI reference model in the next unit which is "Network models".

3.2.1.1   LAN Transmission Methods

LAN data transmissions fall into three classifications: *unicast*, *multicast*, and *broadcast*. In each type of transmission, a single packet is sent to one or more nodes.

- *Unicast :* Unicast is a one-to-one transmission method in which the network carries a message to one receiver, such as from a server to a LAN workstation. In a unicast environment, even though multiple users might ask for the same information from the same server at the same time, such as a video clip, duplicate data streams are sent. Unicast sends separate data streams to each computer requesting the data, thereby flooding the network with traffic.

- *Multicast :* Multicast is a one-to-many transmission method in which the network carries a message to multiple receivers at the same time. Multicast is similar to broadcasting, except that multicasting means sending to a specific group, whereas broadcasting implies sending to everybody, whether they want the traffic or not. When sending large amounts of data, multicast saves considerable network bandwidth because the bulk of the data is sent only once. The data travels from its source through major backbones and is then multiplied, or distributed out, at switching points closer to the end users. This is more efficient than a unicast system, in which the data is copied and forwarded to each recipient.

- *Broadcast :* Concept of broadcast is already discussed in previous section. *Broadcast* is a one-to-all transmission method in which the network carries a packet to all devices at the same time, but a particular machice for which the packet is intended accepts it.

3.2.1.2 Peer-to-Peer LAN & Server Based LAN

On a LAN, we expect to share files, programs, or printers, all without being particularly aware of where the physical resources we're using are actually located. LANs providing these types of services are typically set up either as "*peer-to-peer*" or "*client-server*" LANs, or perhaps as a combination of the two.

☐   **Peer-to-Peer LAN**

All the machines on a peer-to-peer LAN are equal. Provided that the file's owners give permission, a file on machine A can be accessed from machine B, and vice versa. Peer-to-peer LANs do not require any one machine to be a dedicated, high-performance server; service by a peer-to-peer LAN is often cheaper for this reason. Peer-to-peer LANs work well when only a small number of machines are connected to it. But as the size of the LAN grows, peer-to-peer services can become quite disorganized. To serve all its peers, each machine on the LAN must be powerful enough and for this reason its cost increases. For larger LANs, the dedicated client-server LAN architecture becomes more cost effective.

Advantages :

Less initial expense – No need for a dedicated server.

Setup – An existing operating system (such as Windows XP) of the machine may only need to be reconfigured for peer-to-peer operations.

Disadvantages :

Decentralized – No central repository for files and applications.

Security – Does not provide the security available on a client/server.

☐   **Client-Server LAN**

A client-server LAN consists of one or more server machines on which shared files and programs reside and many client machines where people do their task. The LAN server machines usually have higher configuration and are fast because they must serve many users, while the client machines need only to be fast enough for one person to use at a time. Shared printers are either attached directly to a server, or to a print server (a specialized computer attached to the network), or to a personal computer on network that acts as a print server.

Advantages :

Centralized – In case of client-server architecture, resources and data security are controlled through the server.

Scalability – Any or all elements can be replaced individually as needs increase.

Flexibility – New technology can be easily integrated into system.

Accessibility – Server can be accessed remotely and across multiple platforms.

Disadvantages :

Expense – Requires initial investment in dedicated server.

Maintenance – Large networks will require a staff to ensure efficient operation.

Dependence – When server goes down, operations will cease across the network.
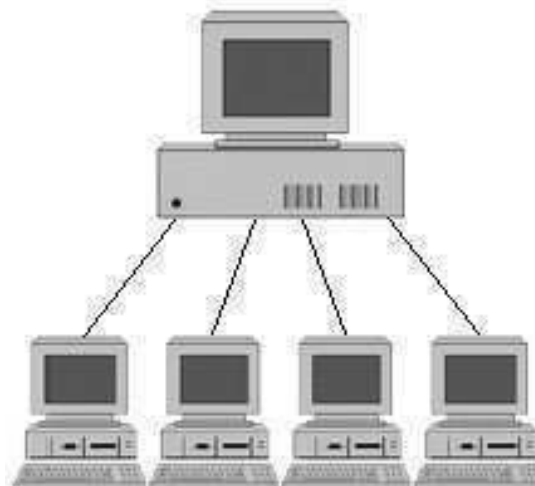
Fig. 3.2: Peer-to-Peer   **Fig. 3.3: Client-Server**

3.2.2   Metropolitan Area Network (MAN)

A *metropolitan area network*, or **MAN**, is basically a bigger version of a LAN and normally uses similar technology. It might cover a group of nearby corporate offices or a city and might be either private or public.

A MAN often provides efficient connections as it has high-speed transmission capabilities which uses some types of telecomminication components to handle long-distance transmission. One very common example of MAN is the cable television network. Another important example is the high-speed wireless Internet access, which has been standardized as *IEEE 802.16.*

3.2.3   Wide Area Network (WAN)

A *wide area network* or **WAN** is a computer network covering multiple distance areas, which may spread across the entire world. WANs often connect multiple smaller networks, such as local area networks (LANs) or metropolitan area networks (MANs).

Typically, a WAN consists of a number of interconnected switching nodes. A transmission from any one device is routed through these internal nodes to the specified destination device. These nodes are not concerned with the content of the data; rather, their purpose is to provide a switching facility that will move the data from node to node until they reach their destination. Traditionally, WANs have been implemented using either *circuit switching* or *packet switching* technologies. More recently, frame relay and *ATM* (*Asynchronous Transfer Mode*) networks have assumed major roles. Frame relay provides higher data rates, lowar costs, efficient handling of bursty data transmission in less expenditure. ATM offers more bandwidth to end users at less cost.

The *Internet* is the best known example of a WAN. Some segments of the Internet are also WANs in themselves. The Internet is a system of linked networks that are worldwide in scope and facilitate data communication services such as *remote login*, *file transfer*, *e-mail*, the *World Wide Web* etc. With the rise in demand for connectivity, the Internet has become a communications highway for millions of users. The Internet was initially restricted to

military and academic institutions, but now it is a full-fledged conduit for any and all forms of information and commerce. Internet websites now provide personal, educational, political and economic resources to every corner of the planet.

3.3 NETWORK TOPOLOGY

In this section we will discuss how computers and others devices are connected in a network.

In computer networking, *topology* refers to the layout of connected devices. Network topologies can be *physical* or *logical*. **Physical topology** means the physical design of a network including the devices, location and cable installation. It defines how the systems are physically connected. Several physical topologies are in use for networks today. Some of the common topologies include the *bus*, *ring*, *star*, *tree* and *mesh*. More complex networks can be built as *hybrids* of two or more of the above basic topologies. The **logical topology** defines how the systems communicate across the physical topologies. The two most common types of logical topologies are **broadcast** and **token passing**.

When we decide which topology we should choose for our network, then there are few basic points that we need to take cares of. The factors that decide which topology we should choose are:

☐   *Cost* : Cost is a factor that plays an important role for the decision of topology. If we want to create a network for 4-5 computers, we should not expense very much in network.

☐   *Scalability*: What is the size of the network that we need to make and is it possible in that kind of topology

☐   *Bandwidth capacity*: The required speed of the network that can be taken care of by any particular topology.

☐   *Ease of installation*: Is it easy to install the network using selected topology.

☐   *Ease of fault finding and maintenance*: If we have a network we will definitely get the problem also; so will it be easy for network administrator to identify the problem and give the solution with ease and in least possible time.

3.3.1   Bus Topology

A network of bus topology consists of a long single cable to which all the computers and other devices are connected. Any node attached to the bus can send signals down the cable to all the nodes of the network; that means, a bus is a broadcast medium. When more than one node start sending data through the bus, they mix with each other and the sent data becomes a garbage. This is called *collision.* To avoid collision there must be some agreement between the nodes so that when one computer starts to send data, others refrain themselves from sending data. To ensure correct data communication, both ends of the cable are terminated by a special device called end terminator.
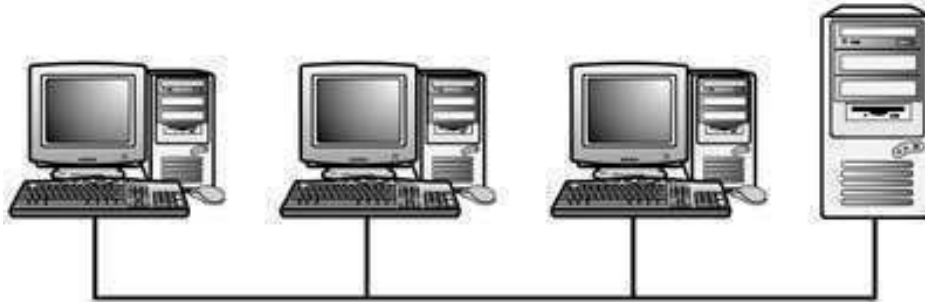
Fig. 3.4: A Bus Topology

Ethernet bus topologies are relatively easy to install and don't require much cabling compared to the alternatives. 10Base-2 (Thin) and 10Base-5 (Thick) both were popular Ethernet cabling options for bus topologies. Some advantages and disadvantages of the bus topology are listed below:

Advantages :
- Bus topology is inexpensive in installation
- It requires less cable than other topologies
- Good for smaller networks not requiring higher speed.
- Easy to add systems to network.

Disadvantage :
- Out-of-date technology. Bus topology was used in the early days of networking because it was inexpensive to use and relatively easy to set up.
- If the backbone cable fails, the entire network effectively becomes unusable.
- Unmanageable in a large network. If more than a few dozen computers are added to a network bus, performance problems are likely to occur.
- Difficult to troubleshoot.

3.3.2   Ring Topology

In ring topology the computers are connected between each other in a way that forms a close loop. In practice, a cable connects the first computer to the second computer, another cable connect the second computer to the third and so on until the last computer is connected back to the first to complete the loop. It should be noted that the topology may not physically look like a circle. The ring means the computers are connected with each other in a logical ring. The interconnecting cables may take any shape in practice. All messages travel through a ring in the same direction (either "clockwise" or "counterclockwise").

Fig. 3.5: A Dual Ring Topology

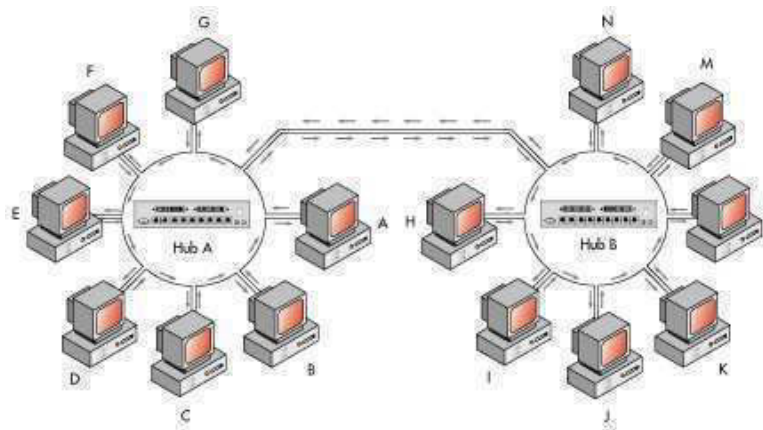In ring topology the communicating computers must follow some agreement between them to avoid collision as it is also a broadcast network. The main difference between the bus and ring is that the ring topology does not require termination. Because the systems are connected all together in a loop, there are no beginning and end point as there is with the bus topology. A failure in any cable or device breaks the loop and can take down the entire network.

Two major network types that use the ring topology are:

i)*Fiber Distributed Data Interface* (FDDI) where a large, high speed networks use fiber optic cables in a physical ring topology.

ii)*Token-Ring networks* that use logical ring topology.

Advantages :

● 　　　No collision of data as data travel in one direction only.

☐ 　　　Easier to fault find. If any point gets broken we can trace that easily.

☐ 　　　No terminator required.

Disadvantages :

☐ 　　　Ring topology requires more cable than bus topology

☐ 　　　A break in ring will take the whole network down.

☐ 　　　Addition or removal of any node can affect the entire network.

3.3.3   Star Topology

In the *star* topology, all computers and other network devices connect to a central device(controller) called a ***hub*** as depicted in the figure.1.11. Each connected device requires a single cable to be connected to the hub. A hub normally accepts data from a sending computer and delivers it to the computer for which the data is addressed. Hence, a star network is not a broadcast network, rather a point-to-point network. Using a separate cable to connect to the hub allows the network to be expanded without disruption to the network. Because each computer uses a separate cable to connect to the hub, the failure of a network connection affects only the single machine concerned. The other computers can continue to function normally.

Fast Ethernet (100Base-TX & 100Base-FX) in a star topology is the most commonly used LAN today. *10Base-T Ethernet* and *1000Base-TX Gigabit Ethernet* also use star topology.

Fig. 3.6: A Star Topology

Adavntages :

☐   Star networks are easily expanded without disruption to the network.

☐   Easy to add/remove devices to/from network

☐   One break does not bring the whole network down. Cable failure affects only a single user.

☐   Easy to troubleshoot and isolate problems.

☐   Widely used centralized management

Disadvantages :

☐   Costs are usually higher than with bus or ring networks.

☐   Requires more cable than most of the other topologies.

☐   If the hub fails, any device connected to it will not be able to access the network.

In the following table, various networks with their cable types, topologies are shown:

Network Type	Standard	Cable Type	Topology
Ethernet	10Base-2	Thin(RG-58)	Bus
Ethernet	10Base-5	Thick(RG-59)coaxial	Bus
Ethernet	10Base-T	CAT3 or CAT5 UTP	Star
Fast Ethernet	100Base-TX	CAT5 UTP	Star
Gibabit Ethernet	1000BaseTX	CAT5, 5e or UTP	Star
Token Ring	all	UTP or STP	Logical Ring

Table 3.7: Network cable types and topologies

3.3.4   Mesh Topology

The mesh topology incorporates a unique network design in which each computer on the network connects to every other, creating a point-to-point connection between every device on the network. A mesh topology is used when there can be absolutely no break in communications; for example, the control systems of a nuclear power plant. The purpose of the mesh topology is to provide a high level of redundancy. If a network cable, computers or other components fail, the data always has an alternative path to get to its destination.
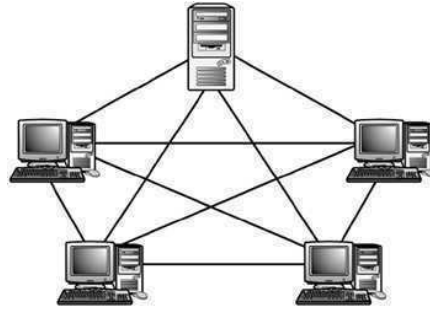
Fig. 3.8: A Mesh Topology

A fully connected mesh network has n(n-1)/2 cables to link 'n' devices. Therefore, every device on the network must have 'n-1' input/output (I/O) ports. For example, in the Fig.1.12, we have five systems that require 10 cables to create a mesh network. This topology is mainly used in environments where high availability outweighs the costs associated with this amount of interconnection. We can see in the figure that the wiring for a mesh network can be very complicated. Further, troubleshooting a failed cable can be tricky. Because of this, the mesh topology is rarely used.

Advantages :
☐ Provides alternative paths between devices in the network.
☐ The network can be expanded without disruption to current users.

Disadvantages :
☐ It is expensive as because a large amount of cabling are required.
☐ Routing network traffic can be difficult because of all the different possible paths between nodes.
☐ It is very expensive to wire up.
There are also partial-mesh networks where some of the nodes are connected to all the others, but others are only connected to nodes with which they exchange the most of the data.

3.3.5 Tree Topology

A tree topology combines the characteristics of bus and star topologies. It consists of groups of star-configured workstations connected to a linear bus backbone cable (Fig. 1.13). This bus/star hybrid approach supports future expandability of the network much better than a bus (limited in the number of devices due to the broadcast traffic it generates) or a star (limited by the number of hub connection points) alone.
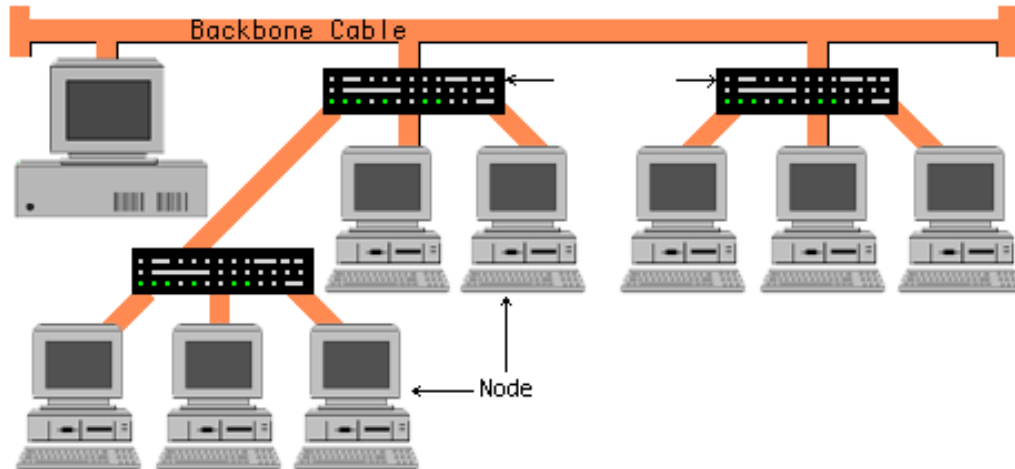
Fig. 3.9: A Tree Topology

Advantages of Tree Topology :
☐　　　The network is easy to extend by just adding another branch.
☐　　　Fault isolation is relatively easy.

Disadvantages of Tree Topology :
☐　　　If the backbone cable breaks, the entire network goes down.
☐　　　More difficult to configure and wire than other topologies.
☐　　　If any hub goes down, all branches of that hub go down.

3.5 ISO-OSI REFERENCE MODEL

　　　　The OSI reference model is shown in Fig 3.10. The International Standard Organization (ISO) developed a proposal for a network model and the resulting model is known as ISO – OSI reference model. This model has seven layers and the layers are :
　　i)　Physical layer
　　ii)　Data link layer
　　iii)　Network layer
　　iv)　Transport layer
　　v)　Session layer
　　vi)　Presentation layer
　　vii)　Application layer
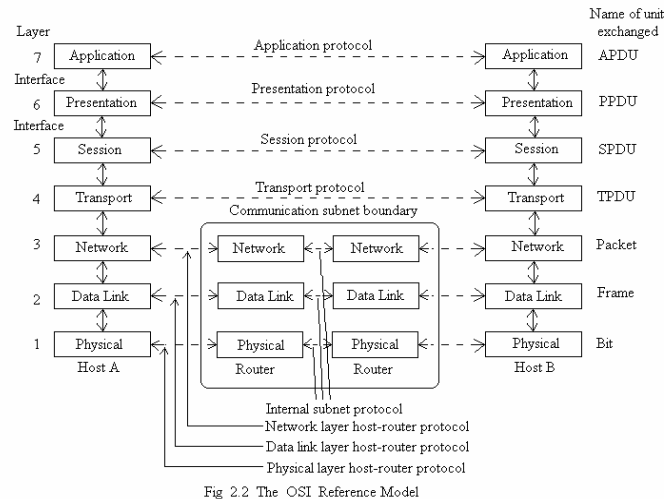
Fig. 2.2 The OSI Reference Model

Fig. 3.10: Layers, protocols and interfaces

(i)The Physical Layer : The physical layer is responsible for transmitting raw bits over the communication channel. This layer is to ensure how to send a 1 bit from the sending computer as 1 bit to the receiving computer; not as 0 bit. The physical layer also deals with the issues of how many bits per second will be transmitted, what level of voltage will be used to represent 1 and 0, whether transmission will be unidirectional or bidirectional, how the initial connection be established and terminated at the end, how many pins of network the connector has and which pin is for what etc etc. Hence, the design issues of the physical layer is mostly mechanical, electrical and procedure oriented.

**(ii)The Data Link Layer :** The data link layer use the raw transmission facility and transforms it to an apparently error- free facility to be used by the network layer. This layer breaks the input data into frames by inserting appropriate frame boundary, transmits the frames sequentially and processes the acknowledgment sent back by the receiving computer. If a frame is completely destroyed by noise burst, it is the duty of data link layer to retransmit it from the source machine. Data link layer also ensures that a fast sender is not allowed to swamp a slow receiver by sending data at a higher rate than it can be handled by the receiver. This is called *flow control*. In a broadcast network it is the duty of MAC (Medium Access Control) sub-layer of data link layer to decide who will access the transmission medium at a particular time.

(iii)The Network Layer : The network layer controls the operation of the subnet. The layer is to determine how packets are routed from source to destination. The routing may be static or dynamic depending on traffic load and availability of channel.

Too many packets may cause congestion (traffic-jam) and control of such congestion is also a duty of the network layer.

The subnet operation requires cost; hence, some accounting function is also there being built into the network layer. When a packet crosses national boundary some other aspects of accounting has to be dealt with by network layer.

Packets have to travel in between heterogeneous network running on different platforms using different network protocol and the network layer is also responsible to resolve all the problems arising out of such situations.

(iv)The Transport Layer : The transport layer is to accept the data from the session layer, breaks it into smaller units if necessary, hands over these to the network layer and ensures that the pieces all delivered correctly to the receiver. The above duties must be done efficiently and in such a way that it will not affect the upper layer in case there is any change in the hardware.

Normally, the transport layer creates individual connection for each session. If high throughput is required, the transport layer may establish multiple network connections, dividing the data among individual connections, thereby improving the throughput.

To reduce cost the transport layer may also multiplex several transport connections onto the network connection. However, multiple connections or multiplexing must not be seen by the session layer.

The transport layer also determines the type of service given to the user of the network. Error free point-to-point connection is the most popular transport layer service where messages or bytes are delivered in order in which they were sent. The transport layer also performs flow control.

(v)The Session Layer : This layer offers facility to different users on different computers to establish session between them. A session allows an user to remotely log into a distant machine and transfer file between the two machines. Session layer perform token management to provide unidirectional communication. It also provides a service called synchronization.

(vi)The Presentation Layer : This layer performs data presentation job by following syntax and semantics rules. Before presenting data to the user, it transforms data into their acceptable form.

(vii)The Application Layer : This layer is the nearest layer to all the network users. It offers variety of protocols that are commonly needed. It helps to transfer file. Different file systems have different meanings in different machines with different data formats etc. When files are transferred from one machine to another with different file systems, the application layer takes the necessary steps to resolve the abnormalities.

3.6 TCP/IP REFERENCE MODEL

TCP/IP reference model was developed much earlier than the OSI reference model. It was evolved from the US Department of Defense's (DoD) research network- The ARPANET. Eventually the ARPANET connected many universities and other government organizations. During the process of interconnecting all these through the existing telephone lines, satellite link and radio, the protocol used for the ARPANET had trouble and therefore, a new architecture was needed to overcome that. The model has four layers, namely:

1. The Host-to-Network Layer.
2. The Internet Layer.
3. The transport Layer.
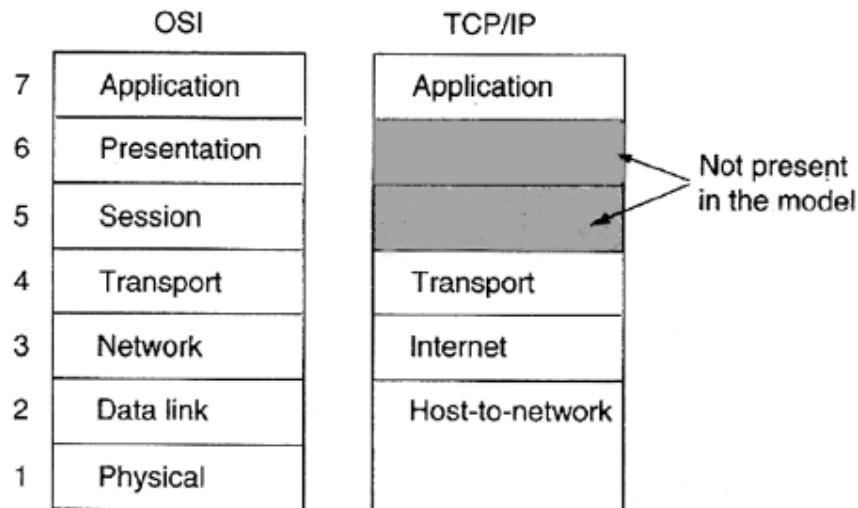4. The Application Layer.

Fig. 3.11: The TCP/IP reference model

1.   The Host-to-Network Layer: In TCP/IP reference model the bottom layer is not defined clearly. Yet we can consider that whatever is there below the internet layer is the bottom layer in the TCP/IP model. In the model, the host has to be connected to the network using some protocol so that it can send IP packets over it.

2.   The Internet Layer: The DoD planned to set up their inter-network in such a way that it had to survive even if a particular link failed in a probable war. So, this requirement led to connectionless packet-switching network instead of a connection-oriented circuit-switching network. The internet layer is designed to fulfill the goal of the architecture in such a way that it becomes the linchpin of the whole architecture. The job of this layer is to pump the packets from the host machine into any network and to help the packets to go to the destination independently. In this style of communication, packets may arrive in a different order than they were sent. This layer has its own protocol called **IP (Internet Protocol)** and a specified packet format. Packets routing as well as congestion avoidance are the major issues in this layer. This layer is similar to the network layer in OSI reference model.

3.   The Transport Layer: The layer immediately above the internet layer is called the transport layer. This layer communicates with the peer layer on the other machine. It has two protocols namely **TCP and UDP.**

        (i)TCP: TCP is a reliable connection-oriented protocol that ensures delivery of byte stream from source machine to destination machine. This layer breaks the byte stream received from the upper layer into messages and passes them to the internet layer. At the receiving machine, these messages are reassembled by the TCP which passes them to the upper layer. Flow control is also another job of this layer to restrict a fast sender from swamping a slow receiver.

        (ii) UDP: UDP is another protocol used by this layer which offers an unreliable, connectionless service. Here, unlike TCP, sequencing and flow control is not done. When prompt delivery is more important than accurate delivery, UDP is used. It is also widely used in one time client-server type communication. Email, video or sound transmissions are some of these applications.

4.   **The Application Layer:** In OSI model, there are session and presentation layers above the transport layer. In TCP/IP model these two layers are absent. So, on top of the transport layer, the application layer is present in TCP/IP reference model. All the high level protocols are present here. TELNET, FTP, SMTP are some of the early inclusions. Later, other protocols such as DNS, NNTP, HTTP are added to this layer.

3.7 INTERNET

The Internet can be defined as a network of globally connected computers that is decentralized by design. This definition can be broken down into three parts. Let's understand each part of the definition in isolation.

It is a network. A network is a collection of computers. The Internet can also be referred to as a network because it is a collection of millions of computers.

Globally connected computers. This means that you can be connected to the Internet, regardless of your location. The Internet has brought people in the world closer by connecting computers located in the remotest of locations.

Decentralized design. The Internet has a decentralized design. That is, there is no centralized body that controls the way in which the Internet functions. The Internet does provide online services that are centrally administered, but as a whole, it would not be incorrect to say that the Internet has a decentralized design. Each computer connected to the Internet is called a *host*. The operator/ user of a particular host can choose from the millions of available Internet services and can also make services available through the Internet.

You can consider Internet to have the following characteristics:

☐   *A complex network* - with simplified definition as a 'network of network'

☐   *Disorganized* - Internet can be cumbersome and confusing, even for experienced users

☐   *A decentralized system* - millions of individual networks and over 200 million individual computers connected through the world

☐   *Composed of many billions of files*(web pages).

☐   *Dynamic* - changing every minute of every day. On an average, a new network is connected to the Internet every 30 minutes.

☐   *Expanding exponentially* - the Internet is growing at the rate not less than 15% per month.

3.7.1 Internet Architecture

It is important to understand what the term "architecture" means. The notion of network architecture was introduced during the Internet research phase by the research community that had developed the ARPAnet protocols. Network architecture is a set of high-level design principles that guides the technical design of the network, especially the engineering of its protocols and algorithms. There are two most commonly used architecture in Internet technology: *peer-to-peer* and *client server architecture*.

3.7.1.1   Peer-to-Peer

Peer-to-peer is a communication model in which each and every node is capable of sharing information and can initiate a communication session. On the Internet, peer-to-peer (referred to as P2P) is a type of transient Internet network that allows a group of computer users with the same networking program to connect with each other and directly access files from one another's hard drives. **Napster** and **Gnutella** are examples of this kind of peer-to-peer software.

3.7.1.2   Client-Server

The Client-Server Architecture is based on the principle where the client computer requests for some data and the data are sent by the server computer through the network. The concept of *client/server* computing has particular importance on the Internet because most of the programmes are built using this design. Servers are powerful computers or processes dedicated to managing disk drives (file servers), printers (print servers), or network traffic (network servers). Clients are PCs or workstations on which users run applications. Clients rely on servers for resources, such as files, devices, and even processing power. The following figure shows the two architectures:
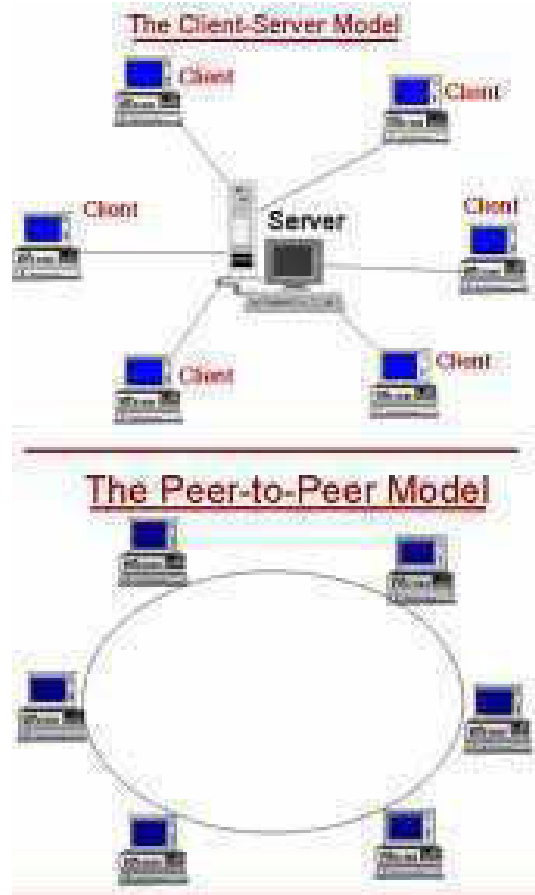

Fig. 3.12: Client Server and peer-to-peer architecture

3.8 INTRANET

An *Intranet* is a Web-based architecture used for managing internal information of an office, company, university or college or even a large library that runs on IP protocols. It means that an intranet is a private network that is contained within an enterprise.. It uses Internet protocols such as **TCP/IP** (Transmission Control Protocol/Internet Protocol), **HTTP** (Hypertext Transfer Protocol), **HTML** (Hyper Text Markup Language) **SMTP** (Small Message Transfer Protocol), **FTP** (File Transfer Protocol), and **AAA** (Access, Authorization, and Authentication). It may consist of many interlinked Local Area Networks and also use leased lines in the Wide Area Network. The main purpose of an intranet is to share information within the organization and computing resources among employees. An intranet can also be used to facilitate working in groups and for teleconferences.

3.9 NETWORK DEVICES

The internetworking devices are the vital tools for communication. Here, we will gain some information about the various hardware that is used to maintain connections between the networks.

□   *Network Interface Card (NIC) :* A *network interface card*, also known as a *network adapter*, is a very important hardware which is responsible for connecting a particular computer to a network. The NIC mediates between the computer(and its user) and the network. Usually, an NIC consists of a printed circuit boardcontaining different electronic components. It possesses a ROM chip that contains a unique number, known as the Media Access Controll (MAC) address. The MAC address identifies the device uniquely on the LAN. It also contains DMA (Direct Memory Access) circuit that allows the NIC to transmit or receive bits from memory without the involvement of the CPU. A NIC contains connector which provides plug-in facility to the network cable. It exists on the Data Link Layer of the ISO-OSI reference model. NIC handles all the details of packet transmission and reception.

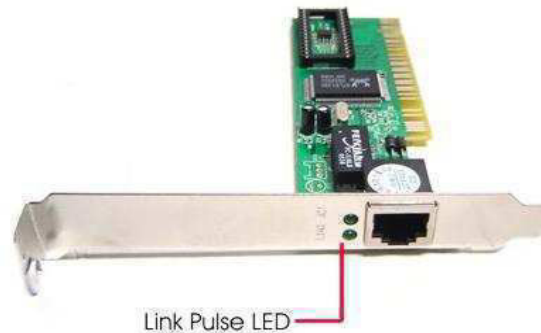**Fig. 3.13: A Network Interface Card**

□   *Modem :* A modem (*mo*dulation-*dem*odulation) is a communication device that converts binary electrical signals into analog signals for transmission over telephone lines and converts these signals back into binary form at the receiving end. Conversion to analog form is called *modulation;* and the reverse process is known as *demodulation.*
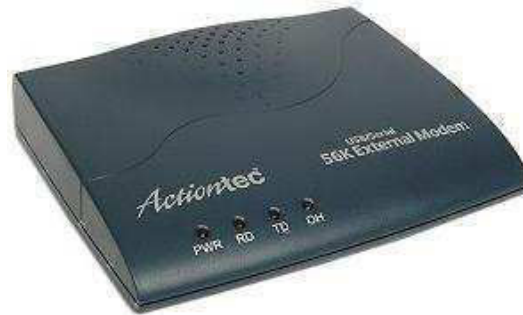
Fig. 3.14: A Modem

At the transmitting end, a bits stream arrives at the modem from computer's serial port. These bits are converted into analog form (modulation) using a predefined modulation technique. This analog signal is transmitted along telephone lines. At the receiving end, the analog signal is converted back to digital form(demodulation). The resulting serial stream is sent on to the computer at the receiving end.

 Repeater : Signals can only travel so far through media before they weaken and become garbled. This weakening of signals is called *attennuation*. Repeaters are used to regenerate the analog as well as the digital signals which are distorted by transmission loss. These are Layer 1(Physical layer) internetworking devices used to combat attenuation. Repeaters take in weakened signals, clean them up, regenerates them, and send them on their way along the network. By using repeaters, the distance over which a network can operate is extended.

For example, 10Base-T (a wiring standard) is allowed to run 100 meters. One repeater can double this distance to 200 meters, as decpicted in Fig.3.15.

Fig. 3.15: A repeater extending network without attenuation

 Bridges and Gateways : As the size of local area networks grew, the management of the networks became more difficult. Controlling traffic flow, maintaining fault monitoring, and adding and deleting stations from the system required more and more sophisticated system management. An alternate method to the computer at the receiving end.

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For example, 10Base-T (a wiring standard) is allowed to run 100 meters. One repeater can double this distance to 200 meters, as decpicted in Fig.3.16.
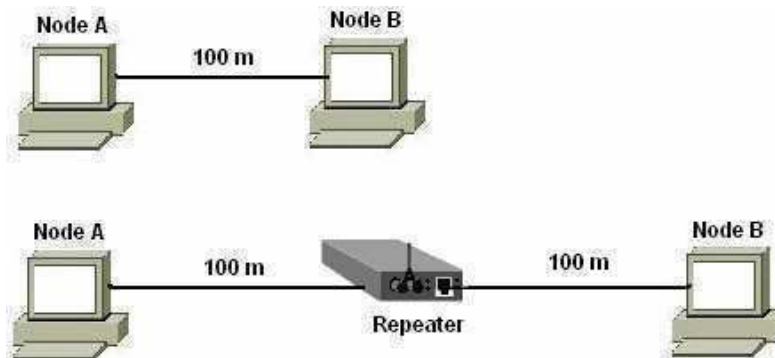

Fig. 3.16: A repeater extending network without attenuation

☐   **Bridges and Gateways :** As the size of local area networks grew, the management of the networks became more difficult. Controlling traffic flow, maintaining fault monitoring, and adding and deleting stations from the system required more and more sophisticated system management. An alternate method to handling larger networks is to divide them into smaller networks that are interconnected using hardware/software systems called *bridges* and *gateways*.

Bridges are mainly used to coonect multiple LANs which operate in the Data Link Layer to construct a larger LAN. The type of data transferred between the LANs must have the same format. A bridge can regenerate a signal it receives like a repeater. The basic function of a bridge is to transfer the frames from one LAN to another LAN. Bridge also has the capacity of frame filtering. It examines the header of each incloming frame frame and based on this information bridge decides whether to discard or forward this frame. Bridge stores the MAC address of received frame, keeps record on which port it has received, and which address belongs to which computer on the LAN.

Fig. 3.17(a) : A typical bridge
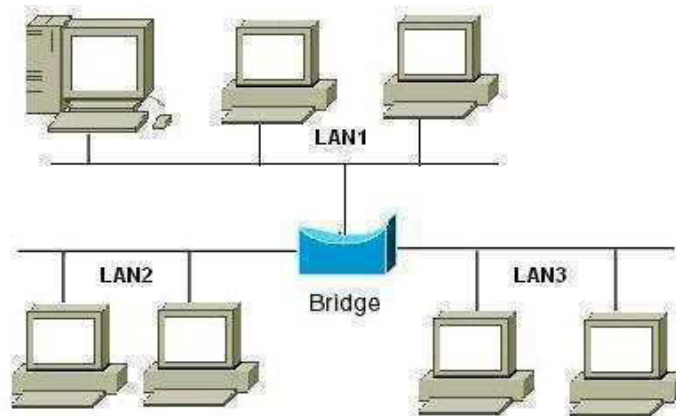
Fig. 3.17(b) : A bridge connecting 3 LANs

Gateways are similar in functions to bridges in that they connect more than one networks. The main difference between bridges and gateways is that the latter can interconnect networks with differing message formats. A bridge does not perform any protocol translation in transferring packets between networks. whereas gateway takes an application message, reads it and interprets it. Hence, it can be used as a connecting device between two inter networks that use different model of references. One of them may use OSI model whereas the other uses TCP/IP model. A gateway is capable of receiving a frame coming from one model, makes necessary conversions and sends it to the other system of model. Thus, gateway relays packets among networks that have different protocols (e.g., between a LAN and a WAN). A gateway can provide security also.

☐   *Hub :* Hubs are Physical layer(Layer 1) devices. Data that comes in one port is sent out to all other ports, except for the port it came in on. Hub does not read data passing through it and does not know the source and destination points. It simply receives the data packets, amplifes the electrical signal and then retransmit data packets on the network. Hubs usually accomodate four or eight nodes, and many hubs include connectors for linking to other hubs. A hub connects nodes that have a common network architecture.

The types of hubs that exist in the network are: *Passive hub* and *active hub*. *Passive hub* receives data packet and retransmits them on the network without amplifying the electrical signal. A multiport repeater is called an *active hub*. They receives the data packets, amplify them and retransmit on the network. For amplification they need the electrical signal.

Fig. 3.18 : A hub

☐   *Switch :* Switches are the core devices in today's modern LANs. A network *switch* is a hardware device that is used to connect computers that require high bandwidth and is also used to connect hubs to form large network. Switches are more expensive but provide better performance to hubs. Unlike hubs, network switches are capable of inspecting data packets as they are received, determining the source and destination device of each packet, and forwarding them appropriately. By delivering messages only to the connected device intended, a network switch conserves network bandwidth and offers generally better performance than a hub.

Fig. 3.19 : A Switch

Two types of switches exist, which are :

Layer- 2 switches : These types of switches are based on the bridging technology. They establish connection between the ports based on the MAC address stored in the address table.

Layer-3 switches : These types of switches are based on the routing technology and are responsible for seting up connection between the ports based on the network address.

☐   *Router :* A router is the primary device responsible for connecting multiple networks together. The function of a router is to provide a path from a node on one network to a node on another network. The two networks may be separated by several intervening networks and possibly, by many miles. The purpose of a router is to forward data packets between networks. It examine incoming packets, chooses the best path for them through the network, and then switches them to the proper outgoing port. Routers are normally used to connect LANs and WANs in the Internet. It performs routing of packets based on their logical addresses. It has a routing table to take decision about the routes of packets. The table is constructed and updated dynamically by following some routing algorithm. Routers work at Layer 3, the Network Layer. In the Fig. 3.20(b), routers connect nodes on different networks.

Fig. 3.20(a) : Some images of Cisco routers
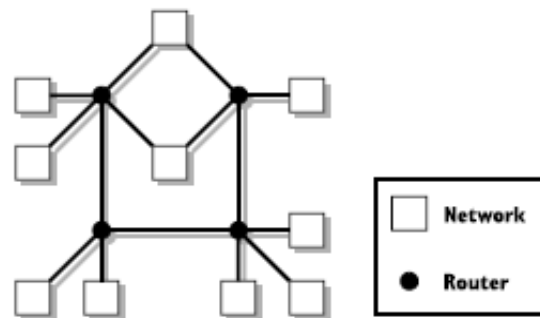
Fig. 3.20(b) : Networks connected with routers

3.10 FIREWALL

A firewall is a device or set of devices designed to permit or deny network transmissions based upon a set of rules and is frequently used to protect networks from unauthorized access while permitting legitimate communications to pass.

Many personal computer operating systems include software-based firewalls to protect against threats from the public Internet. Many routers that pass data between networks contain firewall components and, conversely, many firewalls can perform basic routing functions

3.11 SUGGESTED READINGS

1. Data and Computer Communications by William Stallings, Pearson Education.

2. Data Communications and networking by Behrouz A. Forouzan, Tata McGrawHill.

3. "Web technologies: a computer science perspective", Jeffrey C. Jack son, Pearson Prentice Hall.

4. "Web Technology : A Developer S Perspective", Gopalan, Gopalan/akilandeswari, Pearson Prentice Hall.

3.12 TERMINAL QUESTIONS

1. There are many application areas of Internet. Identify four of them and describe two of them.

2. What is Internet? Explain why Internet is called a 'network of networks'?

3. Define computer network. What are the goals of computer networks?

4. Describe ISO-OSI reference model of computer network.

UNIT 4: OPERATING SYSTEMS

4.1 OBJECTIVES

After going through this unit, you will be able to:

1. Define operating system.
2. Understand different types of operating system.
3. Describe different functions of operating system.
4. Understand files and directories.
5. Understand the concept of algorithms.
6. Describe the basics of data structure.

4.2 INTRODUCTION

Operating System is an important component of a computer system. The primary objective of an operating system is to make computer system convenient to use and to utilize computer hardware and various resources in an efficient manner. An operating system is a large set of software which is also an interface between users and computer systems. It is system software. Operating system also manages resources of the computer system, such as memory, processor, file system and input/output devices.

4.3 OPERATING SYSTEM

An Operating System is program that makes the computing power available to users by controlling the hardware. Another definition is that Operating System is a program that controls the execution of application programs. It is a set of processes permanently or transitively resident within the computer that makes the resources of the computer system available to the user in a consistent, reliable, friendly way.

Operating System can be divided into the *Kernel* and the *Operating System*. The kernel is the essential centre of a computer operating system, the core that provides basic services for all other parts of the operating system. A kernel can be contrasted with a shell, the outermost part of an operating system that interacts with user commands. *Kernel* and *shell* are terms used more frequently in UNIX. Users interact with operating system through Command Line Interfaces (CLIs) or Graphical User Interfaces (GUIs). The operating system thus contributes to the simplification of the human interaction with the computer hardware. They are responsible for linking application programs with the hardware, thus achieving an easy user access to the computers.

Structure

A Computer System is made up of hardware, software and user interface. Computer Software can be divided into System programs and Application programs.

System software manages the operation of the computer itself and the application programs, which solve problems for their users. Operating System is the most fundamental of all the System programs (or System Software). The Operating System controls the entire Computer's entire resources and provides the base upon which the application programs can be written.

Figure 4.1 shows the different layers of the structure of a computer system. The core of a computer system is its hardware and the higher level is the user who interfaces with the computer with the application program with the help of operating system.
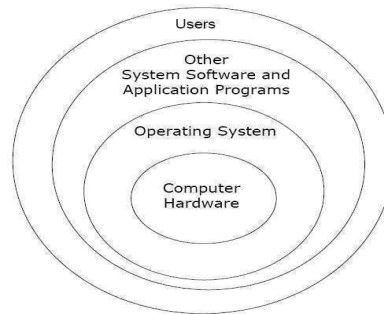
Figure 4.1: Logical structure of a computer system

4.4 TYPES OF OPERATING SYSTEM

Operating systems are categorized based on the types of computers they control and the sort of applications they support. The types are:

4.4.1 Single User Operating System

Single User Operating System is the simplest operating system which allows only one user to work on a computer at a time is known as single user operating system. For example MS-DOS, Windows 98 ect.

Single user operating systems, as opposed to a multi user operating system, are usable by a single user at a time. Being able to have multiple accounts on a Windows operating system does not make it a multi user system. Rather, only the network administrator is the real user.

4.4.2 Multi User Operating System

Multi User Operating System This type of operating system which is running on a computer will manage the work of all different users, without letting them know that they all are actually working on a single computer. A multi user operating system allows a number to work together on a single computer. Each user will be provided with a terminal and all such terminals will be connected to the single computer. For example, UNIX, Linux, Windows XP etc.

A multi user operating system allows many different users to take advantage of the computer's resources simultaneously. The operating system must make sure that the requirements of the various users are balanced, and that each of the programs they are using has sufficient and separate resources so that a problem with one user does not affect the entire community of users. UNIX, mainframe operating systems, such as *MVS*, are examples of multi user operating systems

4.4.3 Single Tasking Operating System

Single Tasking Operating System It is one type of operating system which can execute a single job at a time. So it is known as Single Tasking operating system. For example, MS-

DOS is a single tasking operating system because one can open and run only one application at one time in MS-DOS.

When a single program is allowed to run at a time, the system is grouped under a single-tasking system.

4.4.4 Multi-Tasking Operating System

Multi-Tasking Operating System Multi-tasking operating system allows the user to perform more than one job at the same time on a computer. Now a days most of the operating systems such as UNIX, LINUX, OS/2 etc. are multi-tasking operating system.

Multi-tasking can be of two types namely, pre-emptive and co-operative. In pre-emptive multitasking, the operating system slices the CPU time and dedicates one slot to each of the programs. UNIX like operating systems such as Solaris and Linux support pre-emptive multi-tasking. Cooperative multi-tasking is achieved by relying on each process to give time to the other processes in a defined manner. MS Windows prior to Windows 95 used to support cooperative multitasking.

4.4.5 Multiprogramming Operating System

In multiprogramming technique of processing, the CPU runs several programs at the same time. Multiprogramming is implemented in such a way that it appears as if many programs are being executed concurrently. Multiprogramming keeps CPU busy, switching its attention from one program to another. For example, while one program is waiting for some input or output operation, another program can use the processor because of the high speed of the processor.

Multiprogramming is the rapid switching of the CPU between multiple processes in memory. It is done only when the currently running process requests I/O, or terminates. It was commonly used to keep the CPU busy while one or more processes are doing I/O. It is now mostly superseded by multitasking, in which the processes also lose the CPU when their time quantum expires.

Multiprogramming makes efficient use of the CPU by overlapping the demands for the CPU and its I/O devices from various users. It attempts to increase CPU utilization by always having something for the CPU to execute.

The prime reason for multiprogramming is to give the CPU something to do while waiting for I/O to complete. If there is no DMA, the CPU is fully occupied doing I/O, so there is nothing to be gained (at least in terms of CPU utilization) by multiprogramming. No matter how much I/O a program does, the CPU will be 100% busy. This of course assumes the major delay in the wait while data is copied. A CPU could do other work if the I/O were slow for other reasons (arriving on a serial line, for instance). I/O operations are exceedingly slow (compared to instruction execution). A program containing even a very small number of I/O operations, will spend most of its time waiting for them. Hence, poor CPU usage is seen when only one program is present in memory.

4.4.6 Real Time Operating System

Real time operating systems work towards providing immediate processing and also responding to user's commands in a very short period of time. This type of operating system is more commonly used in chemical industries for process control and scientific processing like airplane control and space vehicle control operations. Success of a real time operating system does not depend only on the correctness of the result but also on the timeliness of the result. For example HP-RT and VT Works ect. It is a multitasking operating system that aims at executing real-time applications. Real-time operating systems often use specialized scheduling algorithms so that they can achieve adeterministic nature of behavior. The main object of real time operating system is their quick and predictable response to events. They either have an event-driven or a time-sharing design.

An event-driven system switches between tasks based of their priorities while time-sharing operating systems switch tasks based on clock interrupts.

4.4.7 Network Operating System

Network Operating System (NOS) is an operating system specifically designed to support interconnection of several computers. NOS provide support for multiuser operating system as well as administrative, security and network management functions. Some examples of network operating system are Windows NT, Novell's Netware etc.

A network operating system has to acknowledge and respond to requests from many work-stations, managing network access, resource allocation and sharing, data protection as well as error control.

4.4.8 Distributed Operating System

A Distributed Operating System hides the existence of multiple computers which are interconnected by a network from the user. That is, the user remains unaware of the fact that many computers are being used to process the data. These computers may be located at many places around the globe.

Distributed Operating System provides single-system image to its users. All these computers work in close coordination with each other. Processes and system resources are managed globally and controlled from specific locations.

An operating system that manages a group of independent computers and makes them appear to be a single computer is known as a distributed operating system. The development of networked computers that could be linked and that can communicate with each other, gave rise to distributed computing. Distributed computations are carried out on more than one machine. When computers in a group work in cooperation, they make a distributed system.

4.4.9 Embedded Operating System

The operating systems designed for being used in embedded computer systems are known as embedded operating systems. They are designed to operate on small machines like PDAs with less autonomy. They are able to operate with a limited number of resources. They are very compact and extremely efficient by design. Windows CE, Free BSD and Minix 3 are some examples of embedded operating systems.

The operating systems thus contribute to the simplification of the human interaction with the computer hardware. They are responsible for linking application programs with the hardware, thus achieving an easy user access to the computers.

4.5 FUNCTIONS OF THE OPERATING SYSTEM

There are various functions performed by an operating system. The basic functions are Input/output management, Memory management, Process management, File and directory management, Security management, Command interpretation.

4.5.1 Input/output management

An operating system makes efficient use of input and output devices and controls them properly. The Input/output management module of the operating system coordinates and assigns different input and output devices, namely terminals, printers, disk drives, tape drives ect. It controls all input and output devices, keeps track of input and output requests, issues commands to these devices and takes measures which would ensure that data is transmitted efficiently and correctly to and from input and output devices.

So far we have studied how resources like processor and main memory are managed. We shall now examine the I/O management. Humans interact with machines by providing information through I/O devices. Also, much of whatever a computer system provides as on-line services is essentially made available through specialized devices such as screen displays, printers, keyboards, mouse, etc. Clearly, management of all these devices can affect the throughput of a system. For this reason, input output management also becomes one of the primary responsibilities of an operating system.

4.5.2 Memory or storage management

Memory is an important resource for a computer system. So memory allocation and deallocation for programs and data is an another function of an operating system. Memory management module of an operating system takes care of allocation and de-allocation of the main memory to various processes. It allocates the main memory and the secondary memory to the system programs, user programs and data. For executing a program, its binary image must be loaded into the main memory to hold data from disk files, the contnts of which it is reading or manipulating at the executing time.

When an operating system manages the computer's memory   there are two broad tasks to be accomplished:

1.Each process must have enough memory in which to execute, and it can neither run into the memory space of another process nor be run into by another process.

2.The different types of memory in the system must be used properly so that each process can run most effectively.

The first task requires the operating system to set up memory boundaries for types of software and for individual applications.

When applications begin to be loaded into memory, they are loaded in block sizes determined by the operating system. If the block size is 2 kilobytes, then every process that's loaded will be given a chunk of memory that's a multiple of 2 kilobytes in size. Applications will be

loaded in these fixed block sizes, with the blocks starting and ending on boundaries established by words of 4 or 8 bytes. These blocks and boundaries help to ensure that applications won't be loaded on top of one another's space by a poorly calculated bit or two. With that being ensured, the larger question is what to do when the 500-kilobyte application space is filled.

In most computers, it is possible to add memory beyond the original capacity. For example, we can expand RAM from 1 to 2 gigabytes. This works fine, but can be relatively expensive. It also ignores a fundamental fact of computing — most of the information that an application stores in memory is not being used at any given moment.

A processor can only access memory one location at a time, so the majority of RAM is unused at any moment. Since disk space is cheap compared to RAM, then moving information in RAM to hard disk can greatly expand RAM space at no cost. This technique is called **virtual memory management**.

Disk storage is only one of the memory types that must be managed by the operating system, and it is the slowest process. Ranked in order of speed, the types of memory in a computer system are:

High-speed cache: This is fast and relatively small amounts of memory that are available to the CPU through the fastest connections. Cache controllers predict which pieces of data the CPU will need next and pull it from the main memory into high-speed cache to speed up system performance.

Main memory: This is the RAM that you see measured in megabytes when you buy a computer.

Secondary memory : This is most often some sort of rotating magnetic storage that keeps applications and data available to be used, and serves as virtual RAM under the control of the operating system.

4.5.3 Process management

Process can be defined as a program in execution. It is the job which is currently being executed by the processor (CPU). During its execution, a process would require certain system resources, such as processor time, main memory, files, input and output devices etc. UNIX operating system supports multiple processes simultaneously. The process management module of UNIX takes care of creation and termination of processes, assigning required resources to different processes currently running, scheduling h processor's time to different processes and providing mechanisms for synchronization and communication among the processes. A process in execution needs resources like processing resource, memory and I/O resources. Current machines allow several processes to share resources. In reality, one processor is shared amongst many processes.

As we know a ***process*** is a program in execution. To understand the importance of this definition, let us imagine that we have written a program called *my_prog.c* in C language. On execution, this program may read in some data and output some data. When a program is written and a file is prepared, it is still a script i.e., it cannot cause any input, processing or output to happen. Once we compile, and still later when we run this program, the intended operations take place. In other words, a program is a text script with no dynamic behavior.

When a program is in execution, the script is acted upon. It can result in engaging a processor for some processing and it can also engage in I/O operations. It is for this reason a process is differentiated from program. While the program is a text script, a program in execution is a process.

4.5.4 Files and directory management

Files and directories are also properly managed by an operating system. Data is stored in a computer system as files. The file management module of the operating system would manage files as well as directories held on various storage devices as well as transfer of files from one storage device to another device. Thus, file management takes care of organization, storage, retrieval, naming, sharing and protection of different files. It also allows files to be read and modified by using text editors or some other file manipulation software packages.

We emphasized that a computer system processes and stores information. Usually, during processing computers need to frequently access primary memory for instructions and data. However, the primary memory can be used only for only temporary storage of information. This is so because the primary memory of a computer system is volatile. The volatility is evinced by the fact that when we switch off the power the information stored in the primary memory is lost. The secondary memory, on the other hand, is non-volatile. This means that once the user has finished his current activity on a computer and shut down his system, the information on disks (or any other form of secondary memory) is still available for a later access. The non-volatility of the memory enables the disks to store information indefinitely. This information can also be made available online all the time. Users think of all such information as files. As a matter of fact, while working on a computer system a user is continually engaged in managing or using his files in one way or the other. OS provides support for such management through a file system. File system is the software which empowers users and applications to organize and manage their files. The organization and management of files may involve access, updates and several other file operations. In this chapter our focus shall be on organization and management of files.

File

Suppose, we are developing an application program. A program, which we prepare, is a *file*. Later we may compile this program file and get an object code or an executable. The executable is also a file. In other words, the output from a compiler may be an object code file or an executable file.

When we store images from a web page we get an image file. If we store some music in digital format it is an audio file. So, in almost every situation we are engaged in using a file. In addition, we saw in the previous module that files are central to our view of communication with Input/Output.

Scheduling

The main motivation for scheduling various OS services is to maximize the usage of CPU resource, memory, and other IO resources. Consider the use of a printer as an output resource. A user takes printouts only once in a while. A printer usage, therefore, can be

shared amongst many users. The motivation to share a resource may come from several reasons. Sharing enhances utilization of resources immensely.

The operating system also establishes and enforces process-priority. That is, it determines and maintains the order in which jobs are to be executed by the computer system. So the most important jobs must be executed first followed by less important jobs. Scheduler selects the most deserving process to run, out of all the runnable processes in the system, based on their relative priority.

Need for Scheduling

Resources may be categorized depending upon the nature of their use.

To enforce temporal sharing of a common resource, the OS needs a policy to schedule its usage. The policy may depend upon the nature of resource, frequency of its use and the context of its usage. In the case of a printer, the OS can spool printout requests. Printing, additionally, requires that once a process is engaged in printing, it must have its exclusive usage till it finishes the current print job. If that is not the case then the printouts from the printer shall be garbled. Some specialized resources, like a flat-bed plotter, require an elaborate initial set-up. So, once assigned to a process, its usage better not be pre-empted. A process that gets such a resource should be permitted to keep it till either the process terminates or releases the resource. This is also true of a transaction which updates a shared data record. The transaction should complete the record's update before another process is given the access to the record.

Processes may need more than one resource. It is quite possible that a process may not be able to progress till it gets all the resources it needs. Let us suppose that a process P1 needs resources r1 and r2. Process P2 needs resources r2 and r3. Process P1 can proceed only when it has both r1 and r2. If process P2 has been granted r2 then process P1 has to wait till process P2 terminates or releases r2. Clearly, the resource allocation policy of an OS can affect the overall throughput of a system.

4.5.5 Security management

It is also one of the most important functions of an operating system to protect its various resources from the outer world. Security management module of the operating system which is executing concurrently in the memory, in such a way that the system ensures data security and integrity. That is, it protects data and program stored in the computer system from destruction and unauthorized access. It keeps different programs and data in such a way that they donot interfere with each other. Moreover, it protects files from being accessed or modified by unauthorized users.

The operating system assigns processors (if a computer has more than processors) to different tasks that must be performed by the computer system. Whenever the operating system finds any processor idle, one of the processors waiting to be executed is assigned to this idle processor. The main objective of the processor management module of the operating system is to ensure that a process is run on each processor at all times.

Computers, with their ubiquitous presence, have ceased to be a wonder they once used to be. Their usage is pervasive. Information access and delivery from, and to, a remote location via internet is common. Today many societal services like railway time-table or election results

are rendered through computers. The notion of electronic commerce has given fillip to provisioning commercial services as well. Most individuals use computers to store private information at home and critical professional information at work. They also use computers to access information from other computers anywhere on the net. In this kind of scenario, information is the key resource and needs to be protected. The OS, being the system's resource regulator, must provide for security mechanisms. It must not only secure the nformation to protect the privacy but also prevent misuse of system resources. Unix designers had aimed to support large-scale program development and team work. The main plank of design was flexibility and support tools. The idea was to promote the creation of large programs through cooperative team efforts.

Security has become a bigger issue now. Much of Unix provisioning of services was with the premise that there are hardly, if any, abuses of system. So, Unix leaves much to be desired in respect of security. And yet, Unix has the flexibility to augment mechanisms that primarily protect the users resources like files and programs.

4.6 ALGORITHM

An *algorithm* is a step-by-step procedure for solving a problem. Algorithms are a fundamental part of computing. It is thus a sequence of computational steps that transform the input into output. To be an algorithm, a set of rules must be unambiguous and have a clear stopping point. Algorithms can be expressed in any language, from natural languages like English.

Example: Algorithm for calculating sum, average and product of 3 numbers:

Step 1: Input X, Y, Z

Step 2: Compute Sum (S) as X + Y + Z

Step 3: Compute Average (A) as S / 3

Step 4: Compute Product (P) as X x Y x Z

Step 5: Display the Sum, Average and Product

Following are the factors that designers should give importance while developing an algorithm:

 • Preciseness of the algorithm
 • All possible circumstances are handled.
 • The algorithm is executable.
 • Termination of the algorithm.
 • Consideration of time and using more resources than required to solve the problem.
 • Efficiency becomes more important for larger programs.

Efficiency of algorithm:

In Computer Science, often the question is not how to solve a problem, but how to solve a problem efficiently. For instance, take the problem of sorting. Many sorting algorithms are well-known; the problem is not to find a way to sort words, but to find a way to efficiently sort words.

The ability to analyze a piece of code or an algorithm and understand its efficiency is vital for understanding Computer Science. Efficiency of algorithm depends on two major criteria, first one is *run time* of that algorithm and second is the *space*. *Run time* of algorithm means the

time taken by program for execution. While implementing an algorithm we use data structures. Some data structure takes more space but improves the run time and some takes less space but it effects the run time of the algorithm. Usually the resource being considered is running time, but it could also be memory or other resources. Suppose the space is fixed for one algorithm then only run time will be considered for obtaining the efficiency of the algorithm.

4.7 DATA STRUCTURES

There is always a tradeoff between the program speeds versus the program storage. Here the storage is the space of the program instruction, normally called as memory and speed is the execution of the program time. Data structures can make memory usage efficient. There are three different types of data structures used to effectively use the program space for the better execution time.

4.7.1 Array

Array implementation is important because, most assembly languages have no concept of arrays. In array, each element is the same size (char = 1 byte, integer = 1 word) and elements are stored contiguously, with the first element stored at the smallest memory address (called the base address). So, the whole trick in assembly language is to allocate the correct amount of space for an array and the address tells the location of an element. To allocate a portion of memory (more than a single variable's worth) (allocating an array within memory):

Examples:

   Array name: .byte 0:8

This gives 8 character-sized elements, numbered 0 - 7, initialized to 0, which is the null character.

   Name: .space 18

This gives 18 bytes of memory (with no implied initial contents).

4.7.2 Stack

We often need a data structure that stores data in the reverse order that it is used. Along with this is the concept that the data is not known until the program is executed (run time). A stack allows both properties. Abstractly, here is a stack. Also called Last in First Out, LIFO Data put into the stack is said to be pushed onto the stack. Data taken out of the stack is said to be popped off the stack. These are the 2 operations defined for a stack. Whereas a stack is LIFO, a queue is FIFO (First In, First Out). Getting into the queue is an operation called enquires, and taking something off the queue is operations called DE queue.

4.7.3 Queue

Queues in Computer Science are very similar to queues in real life. A queue in real life would be a line up at a railway ticket counter or a bank teller. The people are dealt with in the order that they arrived.

Queue called *FIFO (First-In First-Out)* queue. Items can only be removed from the queue in the order that they are inserted into it. Queues are very common in the everyday functions of

computers. In a computer, there may be a queue of tasks waiting for execution, few others for printing, and some are for inputting the data and instructions through the keyboard. Unless the task turns and comes on front, it will not be executed. The most obvious is printing queues. When we send multiple print jobs to a printer, each printing job is inserted at the rear of the queue in the order it was sent. Each job is then printed in the order sent to the printer. Processes waiting to be executed by a CPU are usually in form of a queue also.

Queues are widely used in simulations. In any situation, where the rate at which users' demand for services can exceed the rate at which those services can be supplied, queues are normally used.

Queues are useful in a time sharing computer system where many users share the system simultaneously. For e.g., printer maintains a queue of jobs waiting to get the printer. A queue also stores the keystroke of data as you type on the keyboard. Queues are frequently used in computer programming and a typical example is the creation of job queue by an operating system. If the operating system does not use priorities, then the jobs are processed in the order they enter the system, i.e., first come first served basis. Queues are also used in Internet message packets waiting to be routed.

4.8 SUMMARY

An Operating System is an important component of a computer system. The primary objective of an operating system is to make the computer system convenient to use and utilize computer hardware and various resources in an efficient manner. An operating system is a large set of software which is also an interface between the users and the computer systems. It is also system software.

4.9 FURTHER READINGS

1. Andrew S Tanenbaum, Albert S. Woodhull, "*Operating Systems Design and Implementation*", Prentice-Hall India publication.
2. Deitel & Deitel, Choffnes, "*Operating System*", Pearson Education.

4.10 TERMINAL QUESTIONS

1. What is Operating system? Give some popular OS name.
2. What is process? What are the main objectives of the process-management module of the operating system?
3. Differentiate between multiprogramming and multi-tasking operating system.
4. What are different functions performed by an operating system?
5. Differentiate between network operating system and distributive operating system?

UNIT 5: FILE SYSTEM

5.0 LEARNING OBJECTIVES

At the end of this unit, you should be able to:
1. Define file system
2. Define various types of memories.
3. Understand file properties.
4. Define Network and Internet.
5. Perform file transfer using FTP.
6. Understand emails, chat rooms and Instant messengers.

5.1 FILE SYSTEM

Before we get into anything else we need a basic understanding of how a computer stores data. Inside the computer box there are many different pieces of hardware used for storing data.

5.1.1 Memory

One of these is the **memory**. A Computer's memory is where it stores the data that is currently in use. So, for example, when you have a letter open and are looking at or working on it the computer stores it in memory. All the software currently running is stored in memory too.

5.1.1.1 RAM (Random Access Memory)

This kind of memory is called **RAM** (**Random-Access Memory**). Random-access means that any part of the information may be read or changed randomly, the computer does not have to look through all the data in order so that it can find the right piece. The disadvantage of RAM is that if power goes off, the data is gone.

Figure 5.1: RAM

5.1.1.2 ROM(Read only memory)

There is another kind of memory called **ROM** (**Read-Only Memory**). **Read-only** means that the data on it cannot be changed. ROM is used to store basic information that every computer needs.
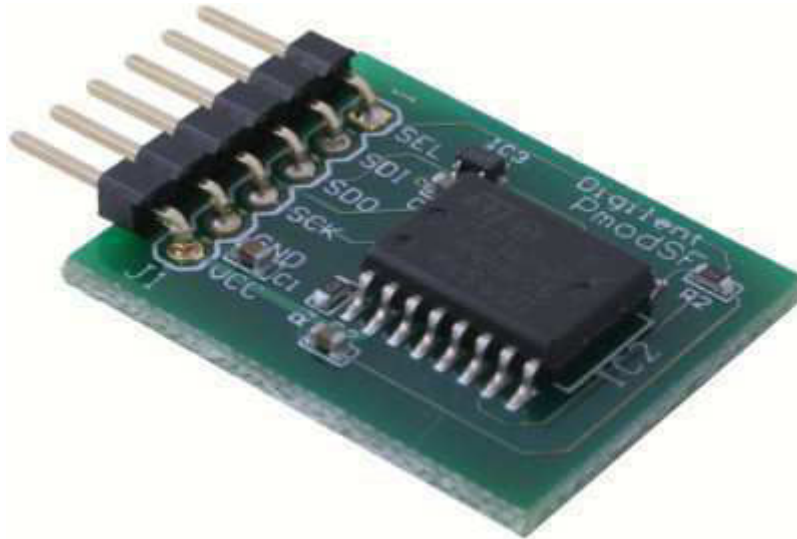
Figure 5.2: ROM

5.1.1.3 Disks

When a computer is turned off, data stored in RAM is lost. Because this would cause you to lose your work all the time, **disks** were created. Disks are round flat objects, but in computer slang they are pieces of data storage hardware that do not need electricity to keep the data stored. There are other things that do this that are not disks, however the things inside of all things called disks are round and flat, so that is how the term came to be. All disks need to be in another piece of hardware that acts as an interface between them and the rest of the computer called a **drive**. There are two main kinds of disks: **Magnetic** and **Optical**.

5.1.1.4 Magnetic

Magnetic disks are the old kind and are slowly being replaced by flash systems (like SSD). They store data by aligning little pieces of metal inside differently using a magnet. Because of the way they store data magnetic disks can be erased or completely destroyed by magnets, heat, and dust. The two most popular forms of magnetic disks are **Hard Disks** and **Floppy.**

Hard Disk Drive (HDD)

Hard disks are stored permanently inside their drive, which is normally installed into the computer box where you cannot see any part of it. Hard Disks can store a lot of data, and are used to store most of the information on computers. The advantage of HDD is cost and capacity. The disadvantage of HDD is that they create noise, are slow and prone to failure. They are slowly being replaced by solid state drives (SSD).

Figure 5.3: hard Disk Drive

Floppy Disk Drive(FDD)

Floppy disks are small disks that you can pop in and out of their drive. All you can see of their drive is a slit in the computer box with a button and a light. You can put in different disks and then take them out and give them to someone so that you can transfer data between your computers. FDD's are now obsolete. They can store only about 1.44 MB , which is way too little. They are prone to damage and are now unsupported for many years.

Figure 5.4: Floppy Disk Drive

5.1.1.5 Optical

Compact disk (CD)

The most popular kind of optical disk is the **Compact Disc** (**CD**). CDs can still be put into and taken out of their drive, making them good for buying programs on, and nowadays for transferring data. Normal CDs that you buy with programs on them are **CD-ROM**s. They are called that because, like ROM, they are read-only. You can also get **CD-R**s and **CD-RW**s, which are not read-only and are not erasable and erasable, respectively. However, CD-R cannot be deleted once it is written (a process known as finalizing). CDs can store around 700MB. And, because CDs store their information with variations in the shape of the disk that reflects a laser differently they cannot be damaged as easily. However, you should still never touch the shiny surface of the CD. CD's are now being replaced by online media, and do not feature in many new computers anymore.

Figure 5.5: Compact disk

Digital Versatile Discs

(**DVD**s) are another kind of Optical disc that works identically to CDs; however they can store much more information than CD's can. DVD's can store usually about 4.3 GB, but dual-layered DVD's can store up to about 9 GB and DVD-RAM can store about the same amount. They are sometimes called Digital Video Discs because of their extensive use in video and films.

5.1.1.6 Flash memory

Today you can also get memory cards that are called **flash memory** or, more properly, **EEPROM**s. These are cards that operate just like ROM that isn't read-only, so they don't lose their information when the power is cut.

Figure 5.6: Flash memory

5.1.1.7 SSD (Solid State disks)

SSD's are based on flash memory. They are much quicker than HDD's, do not make much noise and heat, but they are costlier than HDD's, but the cost of SSD's are rapidly declining. Another concern with SSD's is that the cells on the SSD can last only up to a specific number of write cycles. However, they are not of much concern to home users, as SSD's utilize features such as TRIM to extend lifespan. The lifespan of the SSD will usually be mentioned, which could be anywhere between 30 - 150 TB, which is more than the average lifespan of the computer. Note that defragmentation is not required on a SSD and actually not recommended, as they will not give much benefit and with reduce the lifespan instead.

Figure 5.7: Solid State Disks

5.1.2 Files and folders

All data on a computer is stored in collections called files and folders.

5.1.2.1 Files

Files are the most basic data collections; they store the data for a single thing. A file is the most basic collection of data on a computer. A file can store the instructions for a single program, or the data for a single letter. Folders are collections of files. So a file is like a piece of paper and you put it in a folder.

5.1.2.2 Folders

Also called directories, folders are collections of files.

5.1.2.3 Sorting files

It is very necessary to sort files properly into folders so that you can find them again. Many people have had to redo entire projects because they lost their file by putting it into the wrong folder. We'll be looking at this as we go on.
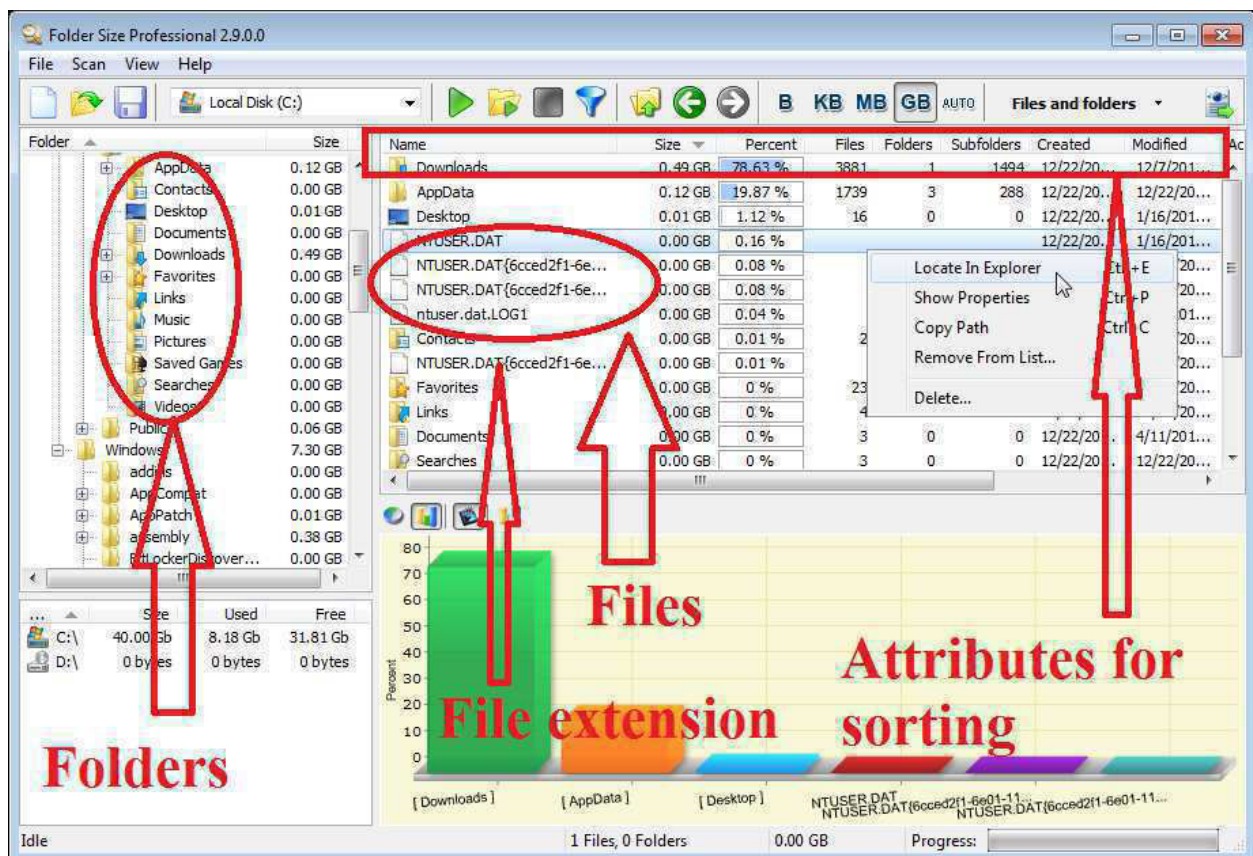

Figure 5.8: Computer explorer

5.1.2.4 File extension

Most files are named with two parts. The first part of the filename is a description of the file. After this comes a '.' followed by the second part. The second part of a filename is called the extension. Extensions are often three letters long and they tell you what kind of file it is. For

example 'exe' files (files with an extension of 'exe') are programs. 'Doc' files are Microsoft Word documents.

Note that since Windows hides the main extension by default, hackers and spammers can use this to their advantage. For instance, a spammer could send you an e-mail inviting you to open a PDF file whose filename is 'Test.pdf' and that's what you see. But in fact, it could be 'Test.jpg.exe' and clicking the file could open up viruses. You can force Windows to show all file extensions by going to Folder Options.

5.1.2.5 Windows Explorer

Besides saving (taking a file you have open in a program and writing it from memory onto a disk) there are many other file operations. These can all be done using the same program. This program is a utility called a file manager. There is a file manager that comes with Windows called Windows Explorer, or sometimes just Explorer. To open Explorer go to 'Start->Programs->Windows Explorer' or Right Click Start, Click Explore, and the Directory should show. Yet in Windows XP, You go 'Start->All Programs->Accessories->Windows Explorer'.

Sometimes Explorer will start you off looking at your 'My Documents' folder, and sometimes it will start you off looking at drive C (C:). There are some basic parts of Windows Explorer.

- The title bar
- The main menu. Below the menu is the toolbar.
- The icon representing a folder.
- The icon representing a hard disk, also called hard drive, because the disks and the drive are in one, sealed, box, (this one is called 'C:', all drives have a letter).
- The icon representing a file(6) is what you click to view sub-folders.

So, if there isn't a tree (the part in the circle) below your hard drive (which should be the icon in the left-hand pane, the part in the square, and should have a name followed by '(C:)' as seen above with (4)) then click the '+' (6) beside it. This is a lot of new stuff so it may be a little bit confusing.

Now we have a tree open below our hard drive showing us all the folders that are directly in the root of the hard drive. Now should be a good time to look at the standard conventions for drives and paths. As you can see above, the drive letter is always is brackets after the name of a drive. The first (or only) floppy drive is almost always 'A:'. If you have a second floppy drive it will be 'B:'. Your first hard drive is 'C:' and your CD drive is 'D:'. If you have more hard drives the other drives change accordingly (i.e. if you have a second hard drive that is 'D:' and your CD drive will become 'E:'). You can have folders inside folders as well as files, and the drive itself acts like a folder. So if you wanted to designate a file called 'Letter.rtf' that is in the folder 'My Documents' and that folder is found in the root of the hard drive 'C:', you separate the elements with a back-slash '\' and come up with 'C:\My Documents\Letter.rtf'.

5.1.2.6 Navigate

Navigate means to make it so you are looking at that in your file manager. For example to navigate to 'C:\My Documents' you would open the tree on 'C:' like we did before (or by double-clicking on it in the right-hand pane). Then you would click the icon that is labeled 'My Documents', or double-click on this icon in the right-hand pane (that is, the part in the octagon). Now navigate to your 'My Documents' directory. It should be found at 'C:\My Documents' or 'C:\Documents and Settings\[Your Name]\My Documents'. Now, to open a file in its program, double-click on its icon in the right-hand pane.

5.1.2.7 Recycle Bin

If you accidentally delete a file you wanted, you can open the Recycle Bin (double-click on its desktop icon) right-click on the file and select 'restore' from the popup-menu. If you want to permanently get rid of all files in the Recycle Bin, right-click on the Recycle Bin and select 'Empty Recycle Bin' from the popup-menu. Deleting or restoring folders works the same way.

5.1.2.8 Sorting your files

If you are going to sort your files properly into folders, you need to know how to create them. To create a folder, navigate to the folder you want the new folder in. Then, right-click on a blank area of the right-hand pane to bring up the popup-menu. Then select 'New->Folder' from the menu. Type the name of the folder and press 'Enter'. To arrange file in folders, you also need to be able to copy and move both files and folders. Moving means that the file or folder goes to the new location and is no longer in the old location. To move a file or folder, simply drag-and-drop the file or folder from where it is in the right-hand pane on top of the folder where you want it to be in either the right or left-hand pane. Copying means that the file or folder stays where it is, and a duplicate is created in the new location. To copy a file or folder you right-drag-and-drop (that is, drag-and-drop by holding down the right mouse button instead of the left one) from its old location on top of the new one. A popup-menu will come up asking if you want to copy, move, or create a shortcut to the file or folder. If you want to copy, select 'Copy Here'.

5.1.2. 9 Searching

If you want to search the whole computer for a specific file or folder there are two possible ways to do it. Some versions of Windows Explorer have a button on the toolbar that says 'Find', click on this. In all versions of Windows you can go to 'Start->Find->Files or Folders' or 'Start->Search'. Some versions of the search have extra features to make it easier that it displays first. To bypass these click 'All files and folders'. If your version came up with text boxes right away you don't have to do this. Once the text boxes are up you can select what drive or folder to search from the combo box. The topmost text box is where you type all or part of the filename.

5.1.2.10 Wildcard searches

You can also create wildcard searches. To do this you type letters that are in the filename along with symbols called wildcards. The wildcards are '*' and '?'. '*' represents an infinite number of characters or nothing. '?' represents exactly one character. So '?ello.doc' would find 'Hello.doc' and 'jello.doc'. 'Si*.*' would find all files that start with 'Si'.

5.1.2.11 File properties

Finally there are file properties. Different kinds of files have different properties and different versions of Windows can have different kinds of properties allowed. You can experiment with these if you want. To open the properties for any file, right-click on it and select 'Properties'. In the window that comes up you can change all the properties of the file that can be changed. In this window it also shows the name and location of the file and its size in bytes, kilobytes (KB, 1 024 bytes, usually estimated at 1 000 bytes), or megabytes. It also shows the attributes, the most commonly used and useful of which is the read-only attribute. When you check the read-only check box and click OK, Windows won't let any program change the file. If you uncheck the box Windows will let programs change it again. This operation can also be done using the 'attrib' command in Command Prompt.

5.2 CONCEPTS AND SETTINGS

We've been moving extremely fast and covering a lot of potentially new and confusing material, so let's take a second to review:

- Computers are machines that process data.
- The desktop is behind everything and is your access panel to everything.
- Shortcuts are only links to other files.
- Everything, programs, shortcuts, letters, and data of all kinds is stored on the computer as files.
- You copy and move files by drag-and-drop.

There was much more covered but this should help you get oriented and give you a good handle on where we've been. Now we're moving forward again. The next big centre to tackle in Windows is the Control Panel (CP). The Control Panel is where you change almost all the main things in Windows. "But didn't we change a lot of things, like the wallpaper and colours and screensaver, without going through there?" Yes, but we took a shortcut. Go to 'Start->Settings->Control Panel' or 'Start->Control Panel' (it may come up with a window or be a sub-menu), then double-click (click if it's a sub-menu) on 'Display'. There it is; the box that we used to change the wallpaper, screensaver, and colours[1].

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[1] **NOTE:** Your Control Panel may come up looking totally different and you may be lost. If there is no icon in your control panel called 'Display' then your computer is running in a 'User Friendly' mode. To switch out of it into the 'normal' view, look at the left-hand side of the Control Panel window and find the option called 'Switch to classic view' and click this.

So now we've reached the main control centre of Windows, what's the first thing? How about a severe warning? The options in the Control Panel are necessary and useful, however do not change anything unless you understand it and know what you are doing. Blindly changing any setting can wreck havoc with your computer.

Now, on to the next item. Desktop themes! We have already changed the way Windows looks, however Desktop Themes (or just Themes) are designed to make it easier. Navigate to 'Start->Settings->Control Panel->Desktop Themes' or 'Start->Control Panel->Display'. These two versions of Desktop Themes are implemented very differently. If you have a 'Desktop Themes' item on your Control Panel, the double click on this icon. In the window that opens, you can select a theme from the drop down box near the top. In the centre area, the different items will change to show you what that Theme looks like. There are two buttons in the top right-hand corner of the window that allow you to preview the Screen Saver, sounds, and cursors. The check boxes below these buttons are for selecting which parts of the Theme to apply. So if you only want, say, the wallpaper from one Theme and everything else from another, then you would uncheck everything except for 'Desktop wallpaper'.

If you don't have a 'Desktop Themes' item on your Control Panel, then Desktop Themes for you are integrated into the Display box. Go to the tab labelled 'Themes' and select the one you want from the 'Theme:' combo box. Just as with the other version there is an area below that will show a preview of what the wallpaper, colours, and some of the icons will be changed to. Click 'Apply' or 'OK' to change your settings to those determined by the Theme.

Now to get to something really useful, installing and uninstalling programs! Most programs nowadays come on one or more CDs. You put the CD (or the first CD) in the drive and it auto-starts (automatically runs the installation program). You follow the instructions, answer the questions, and voila! Your program is ready to use. Sometimes, however, this does not work, and what if you want to remove a program? So, navigate to the Control Panel and open 'Add/Remove Programs' or 'Add or Remove Programs'. No matter what your version of Windows, a list will be displayed of most of the programs on your computer. To remove a program (uninstall it), click on it in the list and then click 'Add/Remove' or 'Change/Remove' and answer the questions, if there are any. To add (install) a new program make sure that its CD or Floppy disk is in the drive and then click 'Install…' or 'Add New Programs' and answer the questions.

Okay, that was easy, wasn't it? All automated and simple. Some computers don't have a password to log on: some never show the box. Some computers can be set up to have multiple usernames and passwords (accounts) so that you can log into different desktops. How can we set all this up? From the Control Panel, of course! Open 'Passwords' or 'User Accounts' on your Control Panel. These two work very differently, and they are both presented below.

If your computer has the 'Users' item, then you have to check something before you can change the accounts. Open the Control Panel item called 'Passwords'. In the window that pops up, click the 'User Profiles' tab (profile is another word for account). There are two radio buttons here. Click the first one if you want to have only one account on the computer, click the second one if

you want to have multiple accounts. Then use the check boxes at the bottom to specify what things can be customised on each account. It is recommended to check all of these.

Once you have enabled using multiple accounts, it becomes easy to create a new account. To create a new account, just type in a different name and password when you start the computer. Windows will automatically create the new account with that username and password to be used every time you log on with them.

If your computer has the 'User Accounts' item then you have a much easier way to change all of these options. To create a new desktop click 'Create a new account'. The computer will ask you what you want to call the new account, this is the username. Click 'Next'. The computer will then ask you if you want this to be a 'Computer administrator' or 'Limited' account. It is recommended to run most desktops as limited accounts, however there are some programs that do not function well this way. There are also many things you cannot do from a limited account (like create a new account, so if the instructions in this paragraph don't work for you, then it is because you have a limited account). Click 'Create Account' and you have a new desktop of that type under that name!

To change an account in 'User Accounts', click on it in the list at the bottom of the window. The window will then give you the list of options of what you can change. You can change the account name by clicking on the first option. You can also change the password by clicking the second option or you can make your account password-less with the third option. To change the picture representing the account you use the fourth option. You change the account type from administrator to limited and vice-versa with the fifth option, and you assign a '.NET Passport' to the account with the fifth option. All of these options save the last one should be self-explanatory. The final option will be discussed when we discuss the Internet. If you have multiple desktops on your computer and the account selected is not the account that is currently logged on, then there appears a sixth option 'Delete the account'. This option starts a wizard to remove the user from the computer.

You can change the 'Welcome screen' to the normal log-on box. To do this select 'Change the way users log on or off' from the main 'User Accounts' screen. Then uncheck 'Use the Welcome screen' and click 'Apply Options'.

All right, was that a lot of stuff or what? Now for some concepts, first of all, viruses, hackers, crackers, scanners, and firewalls. You may have heard some of these terms before. Viruses are what people often like to blame (wrongly) for computer problems. Computer viruses work much the same way as normal ones. They 'infect' a computer by getting their files on its hard disk. They then begin to copy themselves all over the computer and onto anything that might carry them to another computer, such as floppy disks and emails (more on emails when we talk about the Internet). They also do damage while they are on the computer. Many viruses do annoying things, like playing a song or slowing the computer down, however some of them delete files and erase crucial data. Therefore many people get Virus Scanners. There are some major benefits to scanners. The biggest one being that they will destroy many (and maybe all) of the viruses on your computer. Their disadvantages are that they must be updated regularly, and they slow your

computer down. They also give a false sense of security, making you think you are well protected when they may have missed something.
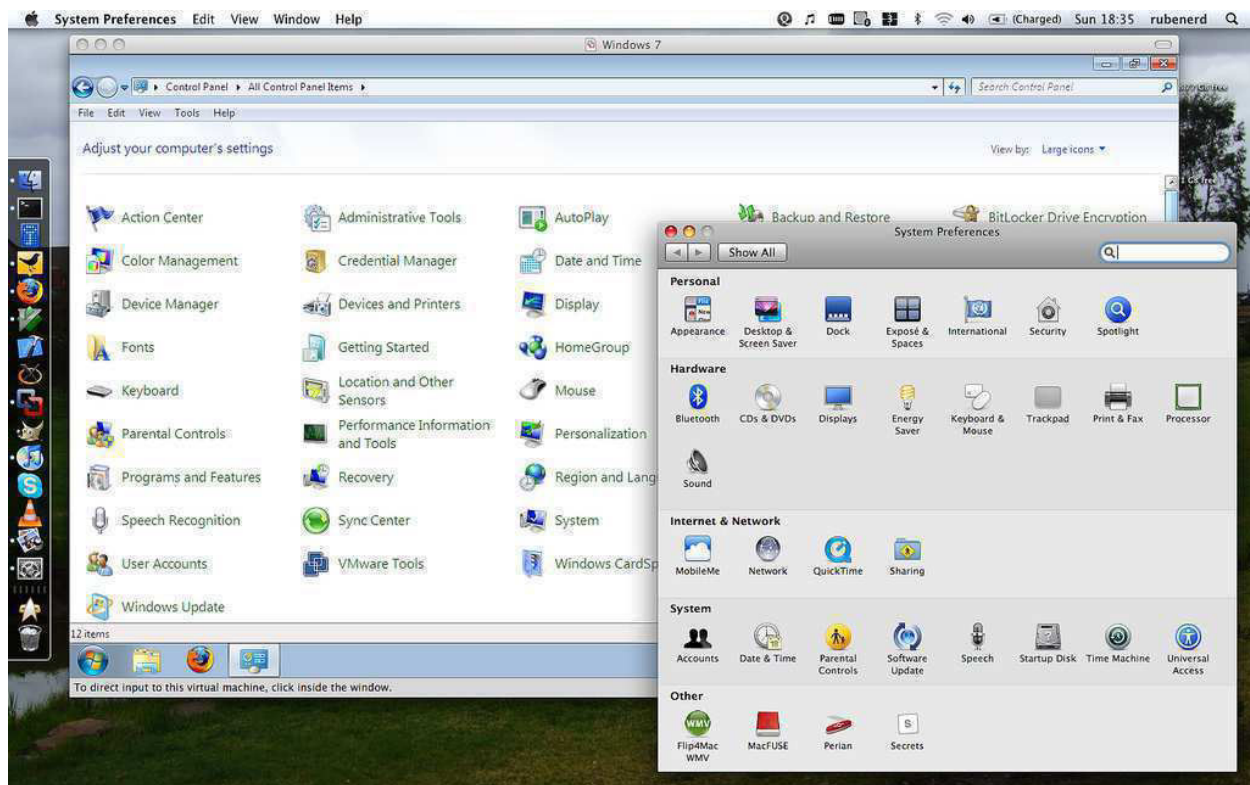

Figure 5.9: Control Panel

Crackers are people who break into computers. Sometimes they do it for fun, sometimes for profit, sometimes to show off. They often touch nothing. Sometimes they will take data or erase it. They tend to prefer government or corporate targets and seldom do serious hackers target normal people. However, to protect against the theft of data, many people run firewalls. Firewalls are pieces of software that identify hacker-like things and cut them off, providing a huge measure of protection for the home user. A similar term, hacker, is often used to refer to crackers, however the term hacker more properly refers to someone who knows how to exploit a computer system for beneficial purposes.

We're almost done, now for error messages. Error messages do not always indicate an error (or at least, not what you call error messages). Many so-called error messages are simply the program asking for more information. The first thing to do when you see an error message is to read it. Many computer experts may seem to violate this rule: that is often because they recognise common messages and know what they say without reading it. Below is a list of common error message buttons and what they usually do:

Button label	What it does
OK	Confirms the operation and shuts the box
Yes	It performs the operation the message box says it is going to
No	It does not perform the operation the message box says it is going to
Cancel	Stops the operation and shuts the box (any data is lost)
Abort	It stops the operation you were trying to do
Retry	Tries again giving to time to make changes
Ignore	Cancels an error message.

Most error boxes have icons beside them to indicate their nature as well:

Icon	What it means
	The computer have some information for you.
	The computer is warning you that there may be something you forgot to do or did wrong.
	There has been a major computer error.

Computers can break. Things can go wrong, viruses can destroy information, and the person using the computer can do something wrong. To protect your data just in case this happens it is necessary to back it up. **Backing up** is making a second copy of data. If you are changing something and do not want to lose the original you can create a second copy on the hard drive to work with, this is a back up. However to protect your data in the case of major computer error it is necessary to back it up *off* of the hard drive. The most common way to do this is to put all of your data on CDs or DVDs.

5.3 NETWORKS AND THE INTERNET

We have now covered all the basic concepts using a computer. In this section we are going to cover the concepts related to networking and using the Internet. A network is a way of connecting two or more computers together so that they can share peripherals (hardware like printers) and data. The most common form of network uses Ethernet. Ethernet is a system of data transfer that uses two different kinds of wire, the older one being like a cable television wire and the newer one being like telephone wire. The newer one is faster and uses an end called RJ-45, which looks like a fat telephone cable end. Normally, computers are plugged into a hub, or

switch using an internal piece of hardware called an Ethernet card or simply a network card and one of these cables. Then they can all communicate with each other.

Figure 5.10: RJ 45 connector

Once the computers can communicate, each item (i.e. printer or folder) that needs to be accessed on the network must be shared, allowing it to be visible to the other computers. Any shared item may be blocked off from general use by a password. One of the other benefits of networks is email (electronic mail). Email allows users to send messages and files to each other. When a new message is received it goes into the user's inbox for storage until it is read, so that a user may receive mail while away from the computer.

Ethernet networks create what is called Local Area Networks (LANs). This means that they are used within one area (i.e. a house or business building) and that is it. All the computers in that area may be connected, but no one else. This can be a problem depending on what you want to do, and a larger network could open up immense possibilities. Enter the Internet. In 1957, just after the USSR launched Sputnik, the American government created ARPA, a scientific research branch for the military. In 1969 ARPA decided to attempt the creation of a national computer network for communications by the military. They did not want to use any standard system, however, not just because of the distance, but because of the fear of nuclear attack. They wanted a network where there was not central hub that could be taken out, but where all remaining parts would function if any other part were destroyed.
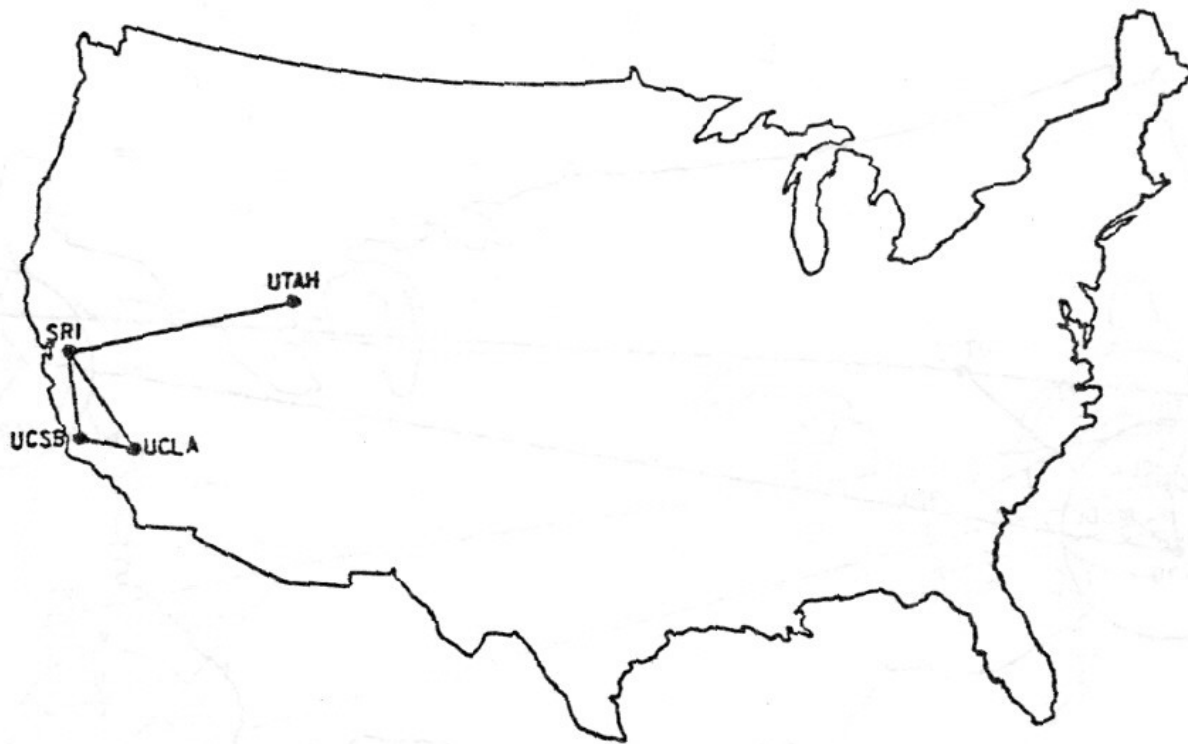
The ARPANET in December 1969

Figure 5.11: ARPANET

After their success, the idea spread. Different government and educational institutions started connecting into the network. Because they all used the same protocol (a set of rules that computers use to communicate, in this case TCP/IP) and the same wires that carried telephone across the country as soon as they plugged in it was the same network. Soon different institutions were creating their own servers (computers that store information meant to be accessed on a network). By 1989 there were more than 100 000 servers on what was becoming known as 'the Internet'. After the Cold War the American government no longer needed a specifically protected portion of this network they had started for their own and the Internet became completely public domain.

In 1990 Tim Berners-Lee invented a protocol based on TCP/IP that could work with it on the Internet and was more flexible. Soon after this, the NCSA (National Centre for Supercomputing Applications) developed Mosaic, a graphical interface for this protocol called the World Wide Web (WWW).

The rest of this chapter is going to be spent looking at the WWW (or 'the Web'). To view Web pages (the electronic documents with pictures and formatted text that you view on the Web) you need to have a Web browser. The two most popular browsers are Mozilla Firefox and Internet Explorer. You can use either one or any other Web browser. If you are not sure what you have, then you will still have Internet Explorer, it comes with Windows.

To do anything online (on the Internet), you must first connect to the Internet. If you don't know how, see Appendix B. After you have connected to the Internet, open your Web browser. Every computer connected to the Internet has an address, called an IP address to identify it. This is a number like '207.194.50.216'. To have to remember something like that to access a web page would be a pain, so Domain Names were created. Domain names are names that you can type in the location bar (more on this below) in your browser. The name is then sent to a server on the Internet called a DNS (Domain Name Service) server that then returns the correct IP address.

You should be connected to the Internet and have your browser open. (You may not have access to the Internet where you live. Your teacher will provide a substitute.) First we should identify the parts of a browser so that we know what we're talking about. Figure 6.1 is a picture of Internet Explorer. If your browser looks a little different, that is okay.

The location bar can also be called the address bar, and it is where you type the URL (Universal Resource Locator or Uniform Resource Locator), which is laid out as follows:

http://   home.golden.net   /~psweber/

The protocol name The domain name The folder and/or file name on the server

After you type the URL press the Enter key and you web browser will take you to the page. The first button on the toolbar is the 'Back' button. It does the same thing as the '< Back' button that we saw before, it goes to the previous screen you were looking at. In this case, the previous web page you were at. The back arrow on the button is a universal icon. Universal icons are ones that are always used to represent the same function. This is different from a program icon like on your desktop or from an icon that only occurs in one program. Even the '< Back' button has a back arrow, that's what the '<' is for. Note that universal icons do not always look exactly the same (i.e. the arrow can look different, as long as it points left).

A universal icon also identifies the next button on the toolbar, the 'Next' button. If you push the back button, then you can go forwards again by pushing this button. The next button on the toolbar has two universal icons used together. A sheet of paper represents a file. An 'X' represents stop. So the sheet of paper with an 'X' on it represents stop loading the file, which is what this button does. Some web browsers have just and 'X' or have a red stoplight on this button. They mean the same thing, stop.

Two icons are also used on the next toolbar button. The paper means the same thing, and the arrows going around mean refresh or reload. This is actually typically a Microsoft icon, although some other companies also use it. The reload button in Netscape as a bent up-arrow, signifying looking at the server again. This button forces the web browser to look at the server and download all the data for a web page again. This is primarily used for when the cache (the place where a web browser stores web pages on your hard drive for quicker access) has an old version of the page that the web browser is displaying and you want to see the newest version of the page.

The next two buttons on the toolbar are the last ones with universal icons. They have a house, and a magnifying glass. A house represents 'home' and this button takes you to your home page.

A home page is a web page that you have set up for your browser to take you to when it first starts or when you click this button. The magnifying class represents 'search' and this button will take you to a web page from which to search the Internet.

There is one more thing you need to know about if you are going to be using web pages, hyperlinks. Hyperlinks (one is labelled in the picture above) can be either text or pictures. When they are text they are often a different colour and underlined. When you click on them they take you to a different web page. The text ones are a different colour once you have been to the web page they point to. Some text hyperlinks are formatted differently, though, and many hyperlinks are pictures. How can you know if something is a hyperlink? Hover your cursor over it and if it is a hyperlink your cursor will turn into a hand, and usually the URL that the hyperlink (or just link) points to will be displayed in the status bar.

The web is very useful for getting information this way, but what if you don't know the URL you need? That is why search engines were created. There are more than 10 billion web pages on the Internet, not all of them are catalogued in all search engines and when you search for something you will tend to get pages that have nothing to do with what you want. However there are some ways to improve your search results.

Go to a search engine. They all work much the same but if you don't know of one go to http://www.google.com or http://www.bing.com. In the text box you can type keywords (words that have something to do with what you want to find). Some search engines have more advanced features that you can explore on your own, but all of them support Boolean operators. The two most useful for web searches are AND and OR. It is best to type them in all caps. AND tells the search engine that the things on both sides must be in the web page (they may be in its text or in its META tags). OR tells the search engine that one or the other must be in the web page. So typing 'boats AND models' will look for all pages containing both words, whereas 'boats OR models' will find any page with either word. You can also use NOT, 'boats NOT Titanic' returns everything containing 'boats' that does not contain 'Titanic'

You can do more complicated strings too, like 'boats AND models OR ships AND kits' which finds all pages containing both 'boats' and 'models' or both 'ships' and 'kits'. You can also do something like this, 'boats OR ships AND models OR kits' which finds anything containing the word 'boats' or 'ships' along with either 'models' or 'kits'.

5.4 FTP

5.4.1 Uploading to an FTP site
Opening the FTP site in Explorer
Uploading to an FTP site in Windows Explorer is fairly simple. Just follow these simple steps: Hold the Windows Key and press "R," then type in "explorer ftp://" followed by your FTP site. Note, It is perfectly fine to have FTP site that starts with "ftp.", such as ftp.example.com, this will mean you have to type "ftp://ftp.example.com", which is perfectly fine.
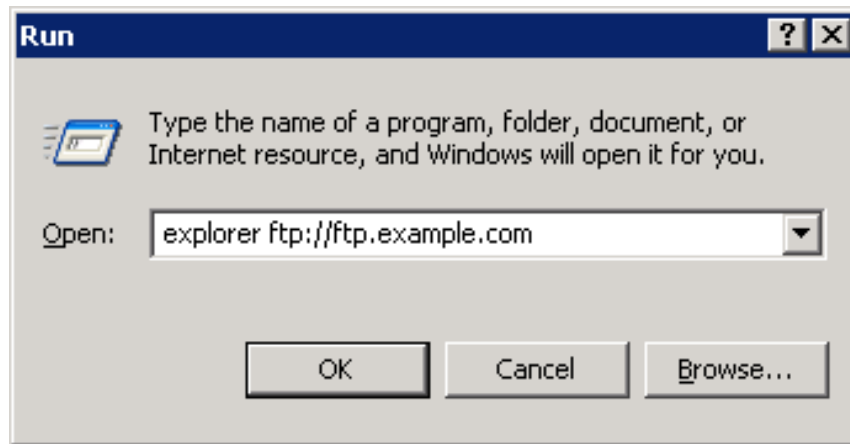
Uploading to an FTP site

To upload files you can either drag them from the folder their in to the ftp folder you just opened; or, *Copy* (Ctrl+c) them from the folder they're in and *Paste* (Ctrl+V) them into the FTP-folder.
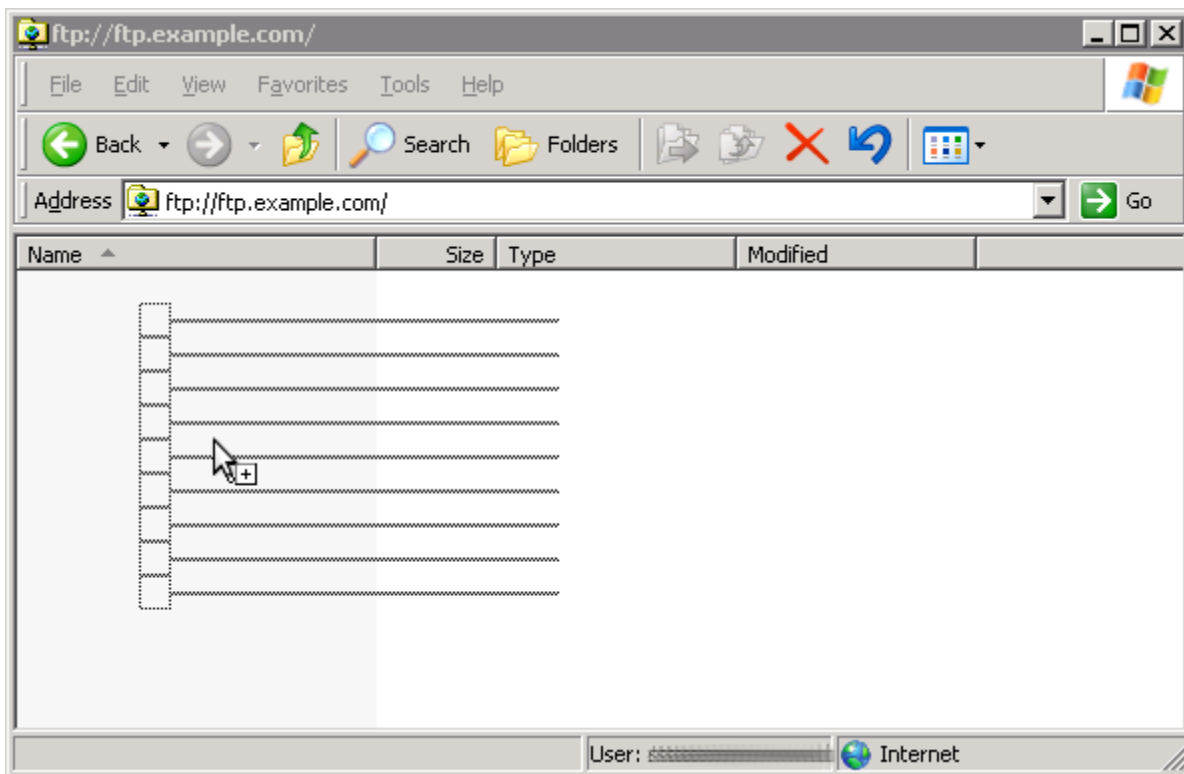
Using Filezilla

Filezilla is an open-source program which can be used to upload files and folders to FTP and SSH sites.

1. Open FIlezilla. You should see the Site Manager screen. If not , go to Files>Site Manager.

2. Click New Site.
3. Type a name for the site (can be anything). In the photograph, it is shown as 1.
4. Type the host (the website).
5. Leave the Port blank, but if you need to enter a different port number, you can do so. The number can vary from site to site.
6. Select the encryption method. This differs by website, but if you are not given any info by the website, you can leave it as it is(Plain FTP).
7. Select the login type. If you do not have any password, select Anonymous. Note that in this case, you can usually not upload anything. If you have a standard user name and password, select Normal.
8. (Not for Anonymous) Enter the login details.
9. Click Connect.
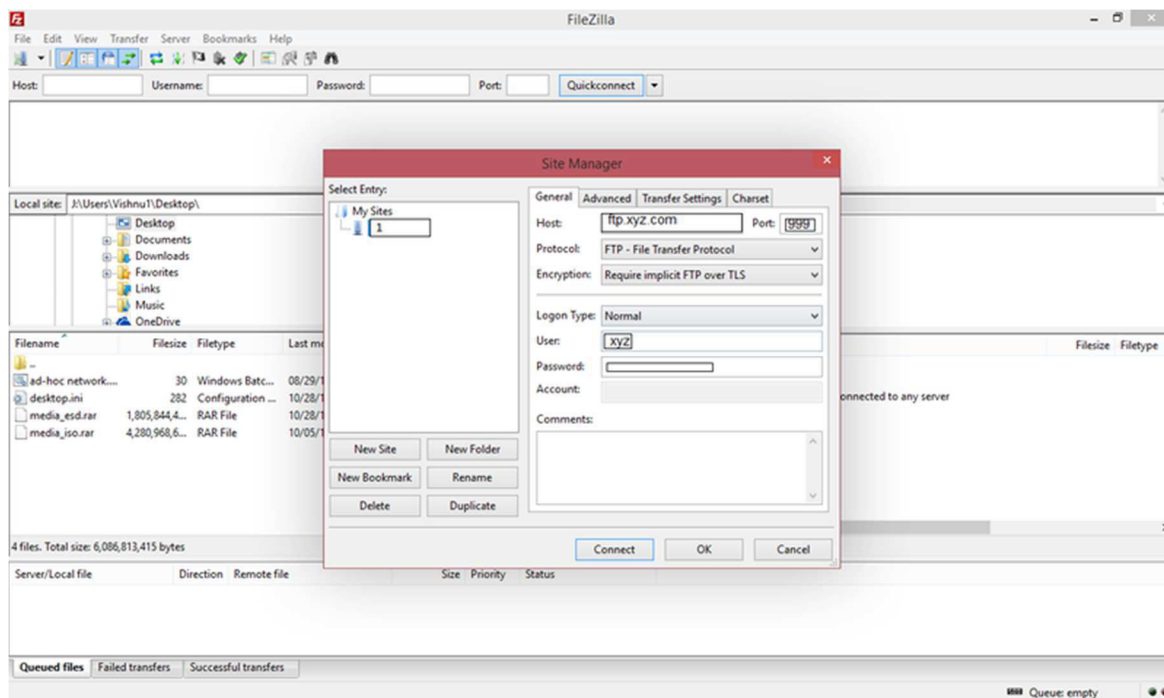
5.5 EMAIL, CHAT-ROOMS, AND IM

5.5.1 E-mail

Email was already partially explained when we talked about networks. The Internet is often called a 'network of networks' but it still has many of the things a network has. One of those things is the ability to do email. The problem with email over the Internet is that it would be impossible to list every person on the Internet in one place, have it current with their names, have those names be unique, and still have it be useful. Since this is the way email on LANs works there needed to be a better addressing system. Email addresses on the Internet work with domain

names, but not with URLs. All email addresses go by the format 'username@domain.name' , where domain is usually the website you sign up. Thus 'julia@yahoo.ca' is the email address for the person who signed up with Yahoo! Canada for an email address under the username of 'julia'. 'julia62@yahoo.ca' is what happens when a name was already taken and someone else wants it.

Email typically operates on two sub-protocols of TCP/IP, SMTP and POP3. SMTP is used for sending email, and IMAP(or the older POP3)is used for downloading (taking off the Internet and putting on your computer) email. Many different email programs exist , for desktops and mobile(iOS , Android , Windows Phone etc). Three of the most popular are GMail(Android), Microsoft Outlook, and Windows Mail. Another popular way to access email is through a web page interface. There are many differences between all the major programs; however there are some things that are standard.

You can create and email, usually by clicking on a button or link labeled 'new message'. The universal icon for an email message (or just for email) is an envelope and the universal icon for 'new' is a star. So there may be an icon of an envelope with a star or something like that. Remember to use tool-tips to find out what buttons with no labels are called. You type one (or more than one separated by a comma) email address in the box labeled 'To:' The 'From:' box is usually filled in automatically (you may be given options if you use a mail client and have 2 or more e-mail addresses, in which case you should choose the e-mail address you want to send from), and then there are 'Cc:'(Carbon Copy) and 'Bcc:'(Blind Carbon Copy).. You can put email addresses in them and the email will be copied to them so that all can see it was copied to all the persons (Cc) or so that they cannot (Bcc), respectively. You then type the text for your message into the big text box at the bottom.

If you are connected to the Internet when you click the 'Send' button (or other similar button) on the email it will go immediately. If you are not (or if the button is called 'Queue') then the messages go into you Outbox until you check your mail. To check your email (which is usually done automatically) (that is, to download new messages and send the ones in the outbox) click the 'Check Mail', 'Send and Receive' or other similar button. A progress bar will appear in the status bar or a window will come up with one so that you can know when it is finished. All new messages go into your Inbox; unless you have filters set up (we will not be discussing filters in this book). You can then move them into other mailboxes that you have created by drag-and-drop. (To create a new mailbox there should be a 'Create new mailbox' on the menu or on a popup-menu for the Inbox.)

Some emails have attachments, these are files that are in the email that you can open and/or save. The universal icon for attachments is a paper clip. You can attach file to you emails by clicking the 'Attach' or similar button. You can open files in email that you receive by either clicking on their icon at the end of an email, or double clicking on it in the 'Attachments:' spot at the top, depending on your program. It is important to take caution when opening attachments, as viruses are easily hidden inside attachments. Also there can be file limits depending on your provider.

5.5.2 Chat rooms

Email is very useful, but what if you want to talk to someone directly? So chat-rooms were invented. Chat-rooms are found on web pages all over the place, some are public, and some you need a membership for. Once you are in, to use it is simple. There is (usually) a list of the nicknames (or handles, fake names people use on the Internet) somewhere on the page, and when you sign in you give it the one you use. You type something in a text box at the bottom and press either the 'Enter' key or the 'Send' or 'Say' button and your messages is visible to everyone in the chat-room in the text box above, including yourself. IRC (Internet Relay Chat) IRC chat was designed to go a step further. You need a program for it and it has a few more features (like the ability to 'whisper' to only one person in the room).

5.5.3 IM (Instant Messaging)

IM (Instant Messaging) was designed for one-on-one or conferencing, much like telephones. Everyone has a unique nickname or number that you must know in order to contact them with a message, send them a file, or do a real-time chat, depending on what your program supports. You add people to your contact list or buddy list and then if you are online, the program notifies you when they are too. Then you can send those messages, chat with messages, or do other things.
Some IM programs also let you send them messages when they are offline that they will get when they come online. Something like email, but it works faster. You can also usually invite other people on your list into an existing chat (or messaging) session so that you can have a little chat room with only people you wants. There are new features coming out for computers all the time. Many IM programs now let you talk with the people while chatting or even see them! The biggest advantage over telephones? You can talk to anyone in the world for any length of time without paying more than your monthly Internet bill. No long-distance charges!

5.6 SUMMARY

1. Random-access means that any part of the information may be read or changed randomly; the computer does not have to look through all the data in order so that it can find the right piece.
2. Read-only means that the data on it cannot be changed.
3. Disks are round flat objects, but in computer slang they are pieces of data storage hardware that do not need electricity to keep the data stored.
4. All disks need to be in another piece of hardware that acts as an interface between them and the rest of the computer called a **drive**.
5. There are two main kinds of disks: **Magnetic** and **Optical**.
6. All data on a computer is stored in collections called **file**s and **folder**s.
7. Files are the most basic data collections; they store the data for a single thing.
8. Also called directories, folders are collections of files.

9. A **network** is a way of connecting two or more computers together so that they can share peripherals (hardware like printers) and data. The most common form of network uses **Ethernet**.

10. Ethernet networks create what is called **Local Area Network**s (**LAN**s).

11. In 1990 Tim Berners-Lee invented a protocol based on TCP/IP that could work with it on the Internet and was more flexible. Soon after this, the NCSA (National Centre for Supercomputing Applications) developed Mosaic, a graphical interface for this protocol called the **World Wide Web** (**WWW**).

12. To view **Web pages** (the electronic documents with pictures and formatted text that you view on the Web) you need to have a **Web browser**.

13. The location bar can also be called the address bar, and it is where you type the **URL** (**Universal Resource Locator** or **Uniform Resource Locator**).

14. The Internet is often called a 'network of networks' but it still has many of the things a network has. One of those things is the ability to do email.

15. Email typically operates on two sub-protocols of TCP/IP, **SMTP** and **POP3**.

16. SMTP is used for sending email, and IMAP(or the older POP3)is used for downloading (taking off the Internet and putting on your computer) email.

5.7 REFERENCES

Images

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UNIT 6: SOFTWARE

6.0 LEARNING OBJECTIVES

At the end of this unit, you should be able to:

1. Explain the purpose of system software.
2. Distinguish among the three major categories of system software.
3. Explain the interaction between the user and the computer and the role of system software to support this interaction.
4. Explain the different types of useful application software.
5. Explain the word processing document life cycle.
6. Explain the purpose of spreadsheets in business.
7. Describe a statistical application that is used to analyze data.

6.1 OPERATING SYSTEMS, UTILITY PROGRAMS AND LANGUAGE TRANSLATORS

There are three different types of software that are part of all computer systems and that ensure that the hardware and application programs can effectively communicate with each other. This software is classified as operating systems, utility programs and language translators.

6.1.1 Operating System

A computer cannot work without an operating system! The operating system comprises a set of coded programs that work with the peripheral devices and computer hardware to control and organize the general operating functions of the computer. Some of these functions include:

- Starting the computer (also called 'booting'),
- Managing and monitoring other programs, memory management, communications management and the management of peripheral devices,
- Enabling interaction between the user and the computer system through the use of external input devices, and
- Monitoring and security of access to data and applications.

6.1.1.1 Starting the Computer

Starting the computer, also called *booting*, is the process of loading the operating system into the computer's memory so it can execute the different operations and mange the hardware devices. When the power button on the computer is turned on to load the operating system, this process is called a cold boot.

If the computer system is already on and the system needs be re-started for a number of reasons (like the hardware stops operating or the user gets an error message), then the process of reloading the operating system is called a warm boot (because the computer was already on). A warm boot in a Windows based PC is normally done by holding down the CTL-ALT-DEL keys at once.

6.1.1.2 Managing Other Programs

The computer system needs to manage the programs that the computer user needs to complete business or personal tasks such as a word processing, Internet research, spreadsheet production and others. The operating system must therefore be able to manage one or more software application programs at the same time. This is known as multi-tasking and the computer is considered a multi-tasking operating environment. For example, multitasking operating systems run more than one application program at a time. Suppose a user has a word processing program, Internet browser and a spreadsheet are open at the same time and the computer user currently typing a report, using the word processing program. The word processing program is called the active program, since it is the current program in use while the other programs – the Internet browser and spreadsheet – are called inactive programs since they are running in the background and are not currently in use.

Since computers use primary memory to increase processing efficiency, the operating system allocates memory spaces for each running program so that the individual programs do not interfere with each other. In order to accomplish this, the operating system uses 'virtual memory' or secondary storage, as an extension of random access memory (RAM).

This is illustrated in the figure 6.1. Sometimes, if there are too many applications opened, then the operating system is unable to allocated adequate memory to each application. When this happens, none of the applications may appear to work and the computer system may need a warm boot.
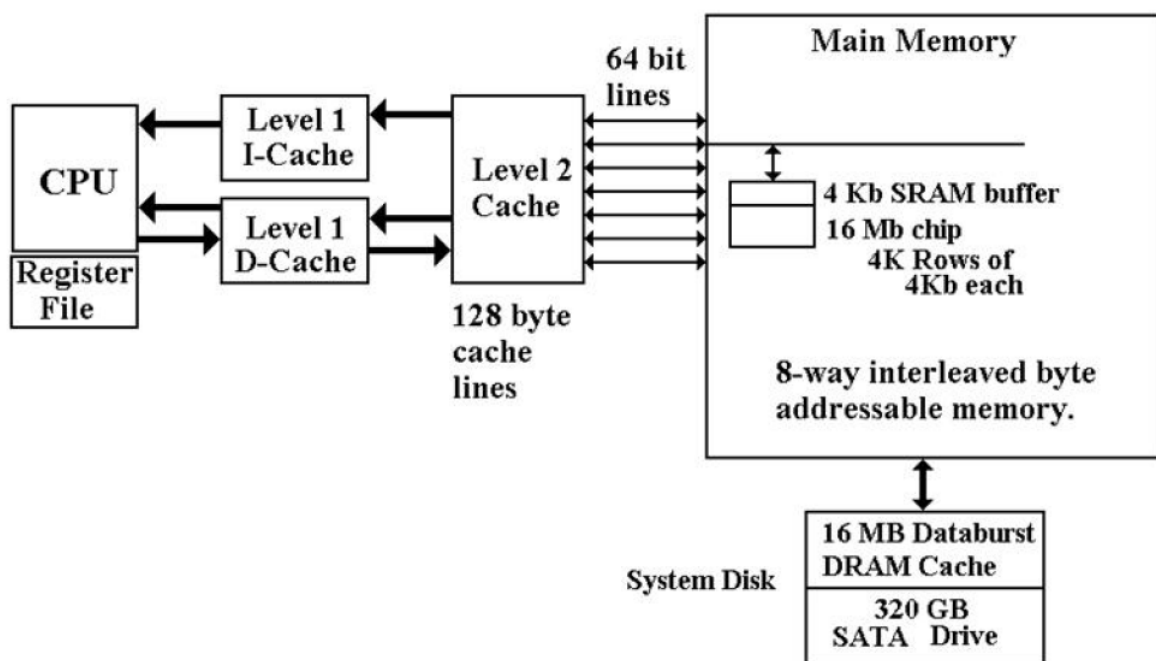
Figure 6.1: Memory CPU Interaction

6.2 TYPES OF OPERATING SYSTEMS

Now that the purpose of an operating system has been explained, let us examine some operating systems that were developed for specific purposes. The Macintosh (or Mac) and the IBM personal computer operate with hardware and software configurations. This is known as the platform. The platform of a computer system is the underlying hardware and software that it allows it to function. For example, the Apple computer was developed with a Mac platform using Motorola chips and unique operating software called "Mac OS" The original IBM computer uses Intel chips and originally employed an operating system called "DOS" or Disk Operating System. Today's PCs now use a Windows based operating system that incorporates many of the original concepts in DOS. Operating systems differ in functionality, flexibility and ease of use. Today there are a number of different operating systems in use. They can be classified as either personal operating systems, network (client/servers) operating systems or handheld operating systems. A representative list of different operating systems is described below.

Operating System(OS)	Type	Main Purpose or Major Development
Unix	Network	These are network operating systems that are powerful. Runs on many types of PCs, mainframes and workstations; is the primary operating system for Internet servers; first multitasking system, widely used by large corporations
Linux	Network	Uses a command line interface; more stable than Windows, but applications using Linux are rare.
Macintosh (MAC) OS X	Personal	Graphical user interface. Also considered the easiest system for beginners
Microsoft Windows 95, 98 and XP	Both personal & network	Capable of Internet browsing, and multimedia support. None of these earlier versions of Windows are supported by Microsoft.
Microsoft Windows NT/2000	Network	Also network operating systems that were designed specifically for corporate and other large businesses, and were also known as client/server systems (one computer 'serves' provides applications for many users 'clients'). Offered enhanced security, and remote access to computer systems among other features
Microsoft Windows Mobile 7	Handheld and Cell Phone	Supports handheld devices and smartphones. Supports integration with other Microsoft software.
Microsoft Windows 7	All Types	The current Microsoft operating system with a number of variants which can be used in all types of computer environments.

6.3 FUNCTIONS OF AN OPERATING SYSTEM

Birbal and Taylor, (2004: 39-40) summaries the functions of an operating system as follows:

6.3.1 Managing computer resources

The operating system allows application software programmes such as word processing, spreadsheet and database packages to communicate with the computer's hardware. For example if you work on a document in Excel and you want to print the document, you just press the print button on the toolbar. Excel will direct the operating system to select a printer to print the document. The operating system then notifies the computer to begin sending data and instructions to the appropriate program to get the document printed. The operating system therefore acts as an interface between the application programmes and the hardware.

6.3.2 Managing files and memory

The operating system manages all files on a computer. It keeps tracks of the locations where programmes and data are stored within the computer's memory. For example, when you open a file that has been saved to the hard drive, you are first instructing the computer to find the file, and then to open it. The operating system also allows you to easily find files stored in secondary storages devices. Other file management functions include copying, erasing, renaming and backing-up files.

6.3.3 Maintaining security

In networks and larger computers each user is given a user name or ID and password to gain access to the computer system. The operating system keeps a register of all these names so that only persons with valid usernames and passwords can access the system. This prevents access by hackers and unauthorised persons. The operating system also keeps a log which records users logged in, the length of time each user stayed on the system, and heat they did. Administrators can check the log to look for security breaches and abuse of resources.

6.3.4 Managing tasks

A computer can perform many tasks simultaneously. One way of doing this is multi-tasking – ability of the computer to run more than one programme at the same time. For example, a user can listen to music on his/her computer whilst at the same time typing a document or typing an e-mail while another e-mail is being sent. In the case of networks the multiuser operating system allows more than one user to access the same data at the same time.

6.3.5 Providing a user interface

Many operating systems functions are never apparent on the computer's display screen. What you do see is what is called the user interface. The interface helps the user to interact with the computer.

6.4 USER INTERFACE

In order to interact with the computer, a user uses a part of the operating system called a user interface. The functions of the user interface are to start application programs, manage secondary storage, such as hard disks, as well as manipulate files and folders, and finally shut down the computer safely.

The three principal types of interfaces include:

- Graphical User Interface (GUI),
- menu-driven interface, and
- Command-line interface.

The Graphical User Interface (GUI) uses graphics or icons which represent various tasks. For example the icon to print is a small picture of a printer 🖨 which when clicked with a mouse, will invoke the printing dialog box. Once the printer dialogue box is opened you can pick other commands that will be used to send your document to the printer. A GUI is a user-friendly interface that eliminates the need to remember complex computer commands or programming languages.

Figure 2: Graphical User Interface

The menu-driven interface is used to show all of the options available to the user in the form of pull-down or pop-up menus. An illustration of a pull-down menu is shown in figure 6.2. Many menu interfaces now include the GUI icons with text menu options.
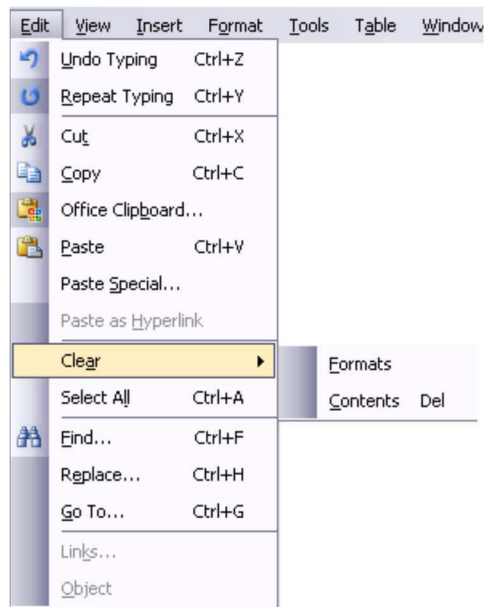
Figure 3: Menu-driven interface

The command-line interface requires the user to type keywords or commands at a prompt, in order to enter data or execute commands. You can experience this type of command when you open the "Run" interface to input DOS based commands to execute an operating system task. This interface is the most difficult one for the average computer users to learn. They are often used in programming applications or in support of systems software.
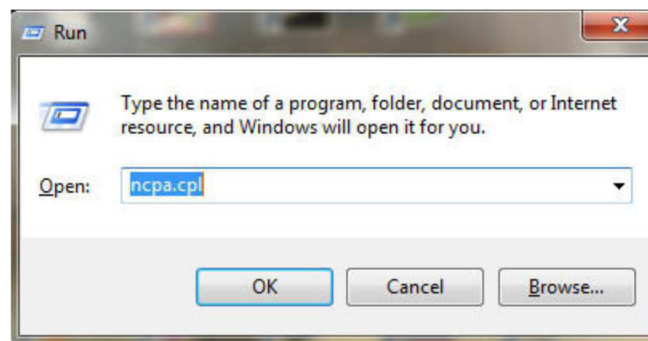
Figure 4: Command line interface

6.5 UTILITY PROGRAMS

Utility programs are tools that help the operating system manage the computer system's secondary or non-priority jobs. These jobs are repetitive in nature. Some examples of utility programs include antivirus software, backup software, disk defragmentation, disk scanning; file compression software, file management programs, and searching software. Often are automatically loaded into member when the system is booted and they operate in the background at the same time as the application program. Often you do not know they are working until they

send you a message like "Virus detected, click here to eliminate". Only then does the user need to engage some form of interface to take the appropriate action.

Utility Program	Description
Antivirus software	Protects the computer from computer viruses. Examples are Norton and Zone Alarm.
Backup software	Used to copy data from the hard disk to another storage medium.
Disk Defragmentation	Re-organizes data on a storage device to improve performance.
Disk Scanning	Involves disk-scanning utilities to detect and fix errors on storage devices, or disk cleanup utilities that remove unused or unnecessary files that are no longer needed.
File Compression	Reduces the size of a file, folder or directory. Popular utility is WinZip.
File Management	Stores files in a hierarchical structure, to enable various tasks such as creating, deleting, copying and moving files, folders, and directories
Search programs	Used to find files, folders or directories on storage devices.

6.6 LANGUAGE TRANSLATORS

Language translators convert the data in a program (source code) into machine language code (object code) so that the computer can then process. The main purpose of translating source code to object code is to create a program in machine language so that the computer can produce the desired results. An example of different types of language translators are compilers and interpreters. The compiler is a computer program or in some cases a set of programs that translates another program's source code into object code all at once, while the interpreter is a set of programs that translate the application program's source code, one line at a time while the program is running.

6.7 APPLICATION SOFTWARE

Application programs assist the user in completing workplace tasks, personal tasks or research when using the computer. They are the programs that a regular user sees and manipulates. This includes word processing, spreadsheet, graphic presentations software and others. .This Topic discusses some categories of application software, including their strengths that enhance a user's productivity.

6.7.1 Personal Productivity Applications

Personal productivity applications serve the needs of various users and have several subcategories. Generally, personal productivity software includes word processing, spreadsheet, presentation, and database programs. Another area, Internet applications, includes Web browsers and electronic mail programs. Multi-media or graphics applications use desktop publishing, as well as editing of photos and graphics, while home and educational applications include personal finance programs, tax preparation programs, reference software and game playing software. These personal productivity programs are usually stand-alone programs which do not depend on other application software to function.

However, there are some applications whose interfaces are the same, and also share data and resources with each other. These applications together are called software suites, and some examples are Microsoft Office - which is the most popular, Corel WordPerfect Office, and Lotus SmartSuite.
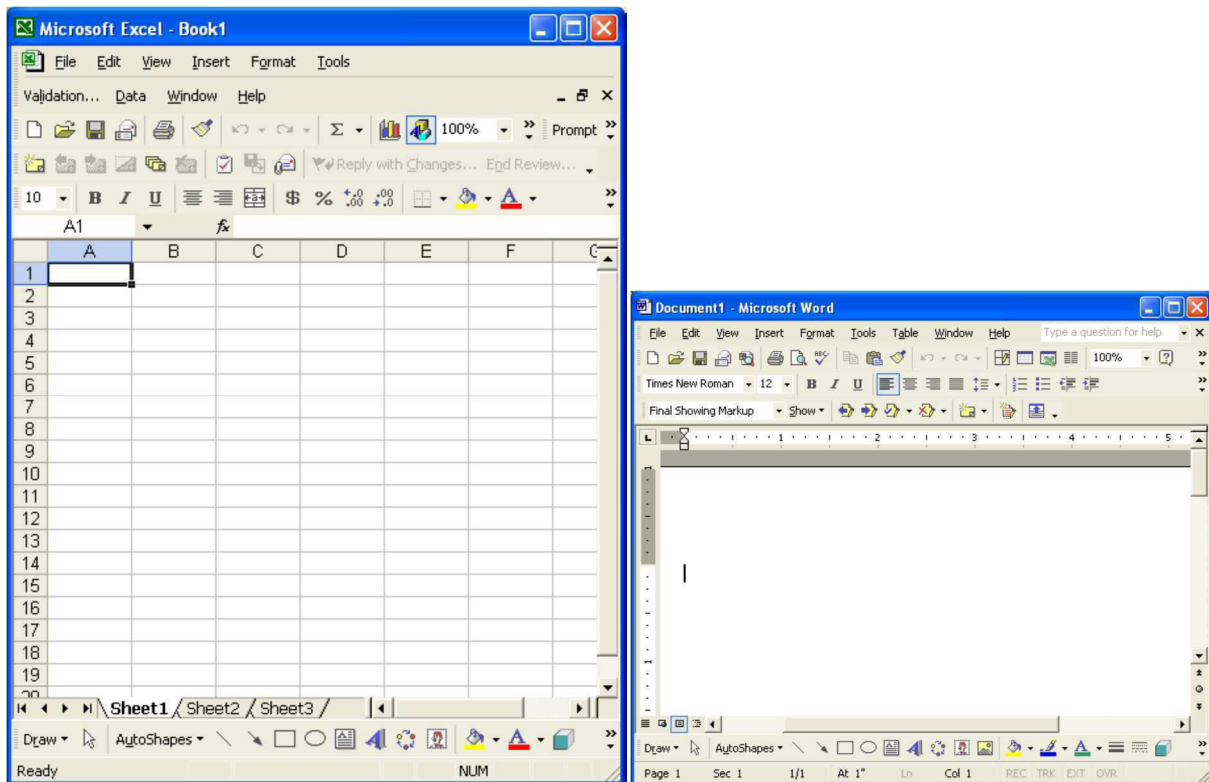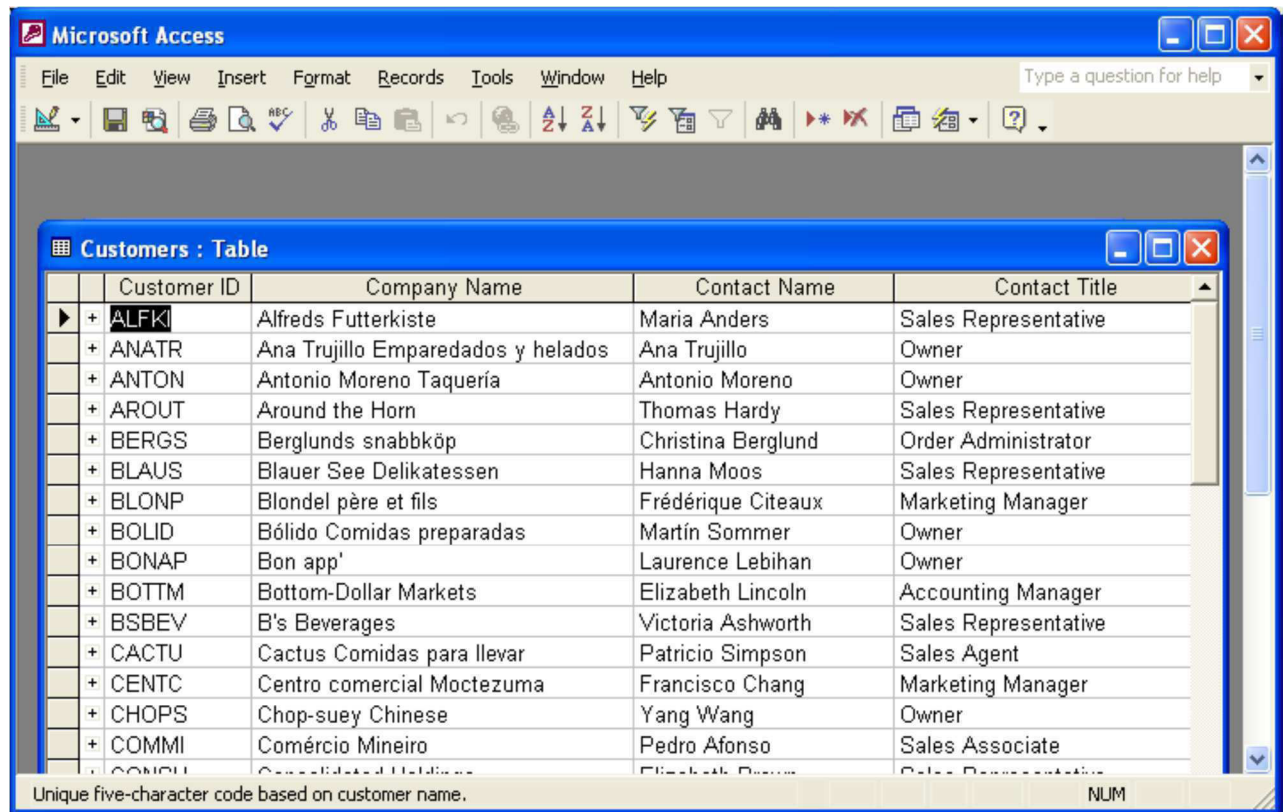
Figure 5: Some useful application software

Types	Description
Financial Software	Provides automated assistance for tax preparation and submission. An example is Turbo Tax.
Accounting Software	Provides assistance for personal accounting and cheque writing. Examples are Quicken and QuickBooks.
Word Processing Software	Provides assistance in formatting, printing documents. Some examples are Microsoft Word, and Corel WordPerfect.
Spreadsheet Software	Provides built-in functions to perform calculations and graphics. Some examples are Microsoft Excel and Lotus
Database Software	Stores, manipulates and retrieves data. Some examples are Microsoft Access, dBase and FoxPro.

6.7.2 Word Processing Features

All word processing software is designed based on the document life cycle. The word processing document life cycle, includes creating a document, editing or modifying the document, formatting the document, saving and finally printing to provide a hard copy. Editing the document allows sections of text to be deleted, moved, or re-typed, and text can also be searched and replaced. Formatting the document enhances its appearance, using various features include using different font types and sizes, line spacing, colours and borders.

Mail merge is one of the powerful features of word processing software. This feature makes it easy to create personalized letters and reports, as well as print addresses on envelopes and mailing labels. With a bit of creative thinking, mail merge can be used to simplify many routine tasks such as personalizing invitations, preparing flyers, making certificates, labeling file folders, and preparing name tags.

6.7.3 Workgroup Applications

These applications are used by two or more users who work as a team to achieve a common task. The programs therefore should support the sharing of information and sections of the work or a project, scheduling group meetings, group electronic mail services, group decision making and conferencing. Some examples of this software are project management software, groupware like Microsoft Share point and collaborative software like WIKIs (an example of a WIKI is Wikipedia).

6.7.4 Enterprise Applications

These applications are used by personnel to support the company in its interaction with customers and employees. Some of the activities include entry of orders, billing, payroll, human resource management, and general reporting activities. Enterprise applications are specialized or tailor made to the specific activities of the company. Examples of enterprise software include PeopleSoft a complete package of company operations and Banner an enterprise system used by universities and colleges to support records management, financial management, course management, student management, etc.

6.7.5 Application Software Development

Some applications are developed 'in-house' specifically for use in the company. Other applications are developed via a contract by technology companies that specialize in producing custom application software for their customers. One example of custom software development would the book ordering process for Amazon.com. Finally, there are off the shelf application software packages which, as the name implies, can be purchased and used without the ability to customize the software.

6.7.6 Spreadsheet Features

Electronic spreadsheets organize data in a grid of rows and columns. Spreadsheet programs are considered a simple database that can be used to manipulate data in the form of numbers, percentages, etc.

The benefits include the elimination of much of the tedious tasks of performing the calculations manually, so that the calculations are generally error-free. Data is automatically recalculated when one value or calculation is changed. What-if analysis allows users to change one value and have the results instantly recalculated. This is very useful in financial forecasting.

The intersection of a row and column is called a cell. A cell is known by its address which consists of a column letter, followed by row number, for example B7. Cells contain:

- a label, which provides text information or headings of the entries in the spreadsheet,
- a value, which is an actual number that is entered into a cell
- a displayed value which is what is displayed in the cell. This displayed value can represent:
- a formula – an instruction to the program to calculate a number, such as 10% of a value, or
- a function – a pre-programmed formula, such as SUM to add some numbers

Spreadsheets produce graphs based on the data given in a visual, easily understood format. Analytical graphs are designed to help users analyze and understand specific data using simple line, bar, and pie chart graphs.

6.7.7 Presentation Software Features

The use of pictures, photos and other graphics in a lecture can help the audience remember and understand what is being presented. This is why electronic presentations have become popular in the oral delivery of many topics. Presentation software is also effective for training purposes since video clips can also be included to illustrate certain topics.

Presentation software programs such as Microsoft PowerPoint presents information, usually in point form on many pages called a 'slides'. Presentations can be projected and enlarged using a projector. Indeed the presentation can be published on the Internet as well as printed as outlines or scaled slides on paper. The usefulness of presentation software includes the easy updating or re-arrangement of the slide content, the inclusion of multi-media to enhance the audience's understanding of the content, the content can be viewed be a larger audience since the presentation can be magnified as necessary, and the presenter can use links within the presentation to link to other documents, files and web resources.

6.8 PROPRIETARY VERSUS OPEN SOURCE SOFTWARE

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Take note: In practice, for software to be distributed as open source software, the human-readable form of the program (the source code) must be made available to the recipient along with a notice granting the above permissions. Such a notice either is a free software license, or a notice that the source code is released into the public domain.

Figure 6: Commercial Software

Figure 7: Open source software

6.9 SUMMARY

The major systems software concepts discussed in this unit were:

- System software monitors the activities of the computer so that it functions efficiently.
- The operating system comprises a set of programs that work with the peripheral devices and computer hardware to control and organize the general operating functions of the computer.
- Operating systems differ in functionality, flexibility and ease of use.
- A platform of a computer system is the underlying hardware and software that it allows it to function.

- The functions of the user interface are to start application programs, manage secondary storage, such as hard disks, as well as manipulate files and folders, and finally shut down the computer safely.
- The Graphical User Interface (GUI) uses graphics or icons which represent various tasks.
- The command-line interface requires the user to type keywords or commands at a prompt, in order to enter data or execute commands.
- Utility programs are tools that help the operating system manage the computer system's secondary or non-priority jobs.
- Language translators are these systems programs convert the data in a program (source code) into machine language code (object code) that the computer can then process.
- Windows Explorer is a tool for organizing files on disk and uses several important components to manage drives such as disks (floppy disks, CDs, DVDs, and memory sticks), folders and files.
- Files are a collection of information, data, or program files.
- Folders are used to organize where the files are located, so that a particular folder may contain all spreadsheet files, while another folder can contain all word processing files.
- A disk is a secondary storage device such as a floppy disk, CD, DVD, or memory stick, where folders and files can be stored.
- The root folder is the main or general folder found on all disks.
- Folders created within the root folder, are called subfolders.
- Deleting folders also removes files and any subfolders in that folder.

The application software concepts discussed in this unit were:

- Application software is what users require to complete their tasks, while system software is the software that interfaces between the hardware to perform what is required by the application software.
- Personal productivity software programs are usually stand-alone programs which do not depend on other application software to function.
- The word processing document life cycle, includes creating a document, editing or modifying the document, formatting the document, saving and finally printing to provide a hard copy.
- Mail merge is one of the powerful features of word processing software which makes it easy to create personalized letters and reports.
- Workgroup applications are used by two or more users who work as a team to achieve a common task.
- Enterprise applications used by personnel to support the company in its interaction with customers and employees, such as entry of orders, billing, or payroll.
- Electronic spreadsheets organize eliminate much of the tedious tasks of performing numerical calculations manually.

- Spreadsheets produce graphs based on the data given in a visual, easily understood format.
- The usefulness of presentation software includes the easy updating or rearrangement of the slide content, and the inclusion of multi-media to enhance the audience's understanding of the content.
- SPSS (Statistical Package for the Social Sciences) is a software application that manages data in a systematic way in order to perform statistical analysis on a set of data.

System software plays an important role in the proper functioning of a computer system. This unit explained the three main programs that comprise system software, namely operating systems, utility programs and language translators. Of course different types of system software are necessary for the different types of operating systems available. The user interface was also discussed as a mediator between the user and the computer system, to ensure that the computer system performs certain complex or other mundane tasks for the user.

This unit also introduced personal productivity software or applications software which are stand-alone programs that do not depend on other applications to function. Some popular application software programs discussed were for word processing, spreadsheet analysis, presentations, and statistical analysis. Some other applications such as workgroup and enterprise applications were also introduced, since they are also widely used in the day-today tasks in many businesses.

6.10 REFERENCES

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UNIT 7: BASIC COMPUTING USING WINDOWS

7.0 LEARNING OBJECTIVES

At the end of this unit, you should be able to:
1. Define a computer and a peripheral device
2. Understand types of computer
3. Turn on and turn off a computer
4. Define a software
5. Understand various software types

7.1 COMPUTERS AND PERIPHERALS

7.1.1 What is a computer?

A computer is an automatic, electronic, data-processing machine that takes in facts and figures known as data, and then processes or organizes it in some useful way. Afterwards it outputs, or displays, the results for you to see as information. Keep in mind that data is not information. Rather, information is the knowledge that you, the end-user, derive from accurate data that are entered into a computer. Only after processing, is data transformed into information which is then used for decision making. (Almost) each part of a computer can be classified as either hardware or software.

7.1.2 Hardware

Hardware refers to all of the physical components of a computer. These parts may include:
- A display component (commonly a monitor)
- A keyboard
- A pointing device, usually a mouse or track pad
- Any cables or wiring
- Any buttons found on the computer, such as a power button
- Internal components such as a processor, memory, mass storage and a motherboard
- A printer

7.1.2.1 The display

Many people mistakenly think that the part of the computer that normally displays pictures and text is the computer. This is usually not true. That part is called the **monitor** or **display**. With a standard desktop computer, the part that does the actual computing is often in a separate box. With a laptop or a notebook, the computing is done in the hardware under the keyboard. Also, you may call the whole assembly of all the hardware (the computer and the monitor, for example) the computer. Occasionally though, the computer and monitor are built together, in which case they are commonly referred to as **All-in-One Desktop Computers**.
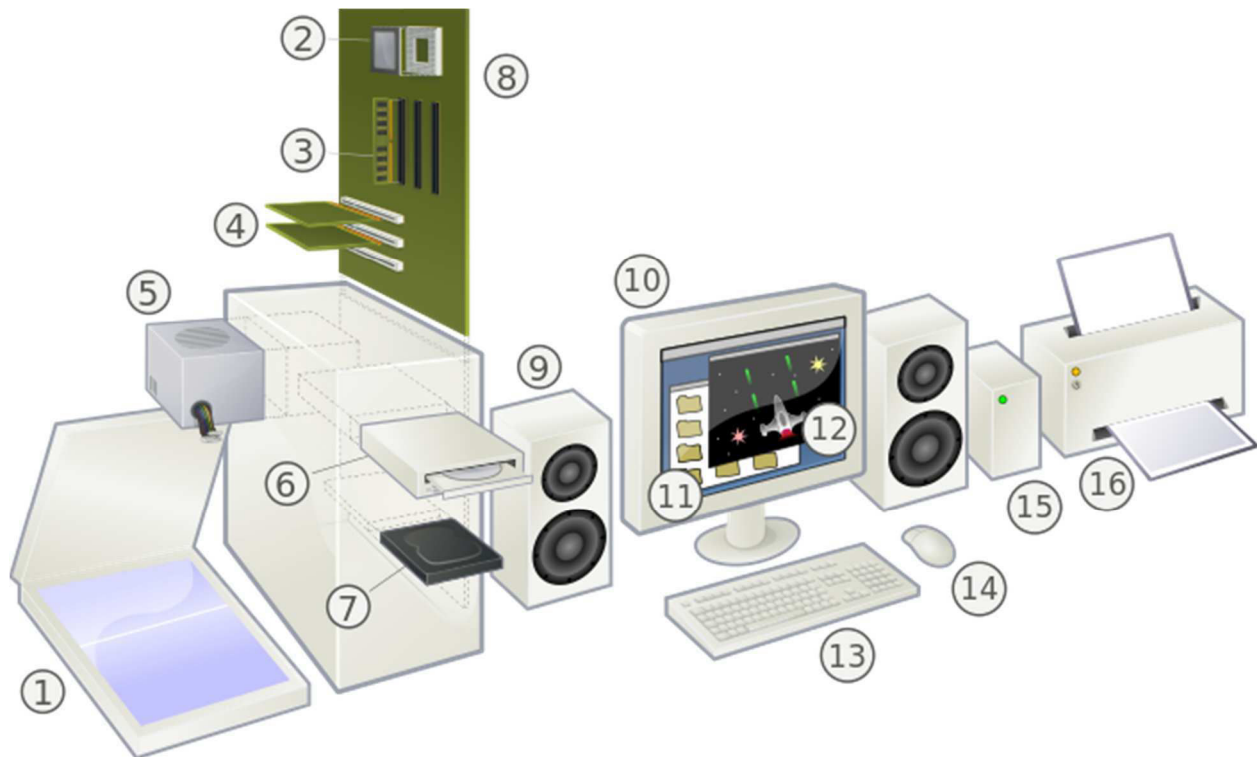
Figure 7.1: Computer and Hardware

1. Scanner 2. CPU 3. RAM 4. Expansion cards 5. Power supply 6. Optical disc drive (CD/DVD/Blu-Ray) 7. Hard drive 8. Motherboard 9 Speakers 10. Flatscreen display 11. System software 12. Application software 13. Keyboard 14. Mouse 15. External hard drive 16. Printer

There are different types of monitors. One of these is the one already shown. It is called a **CRT** monitor, which is similar to a old television. It uses more electrical power than the other popular kind, called **LCD**s . However, CRT monitors work faster, which makes them better for fast games because the movement will blur less , but LCD's have already caught up. LCDs are thinner than CRTs, but they are generally more expensive. As of now , CRT screens are no longer sold. Some monitors use touchscreens, where you can interact with the monitor by touch. Monitors are only one way the computer can output information for you to see.

7.1.2.2 Printers and scanners
Another popular output device is called a **printer** . Printers are used to put data on paper. This is called **hard copy**; what monitors show is called **soft copy**. There are different types of printers , like Xerox , laser and deskjet , with the last one being the cheapest of the three. There are also printers which can also scan/fax , they are called All-in-one. Scanners are devices which scan the input for viewing on the computer.

7.1.2.3 Input devices

There are also different kinds of input hardware. The two most important of which are the **mouse** and the **keyboard**. A mouse is used to move the **cursor** (or arrow) around the **screen** (monitor display). A keyboard is used to enter (**type**) letters, numbers, and other symbols into a computer.

7.1.3 Software

Software is all of the instructions and programming that a computer uses to do what you ask it to do. Packages of software are often called programs, and an operating system is a collection of programs that help all the other programs run. Think of software as the power behind the hardware. Without software, your computer doesn't do anything. Without hardware, the software can't exist. Computers do not think for themselves, so they need software, which is made to manipulate the computer's hardware in such a way that you, the user, can understand.

As an example, a calculator is a very simple computer. It is not as complex or versatile as your net book, laptop, or desktop computer though. You input information as series of key presses, and the calculator computes the result which is displayed as output on a small screen. Since calculators are faster than humans this creates utility in the form of time saved. Calculators can also repeat calculations much more easily than humans can.

Computers store all data in binary code, which is a number system that only uses ones and zeros. One digit in binary code is called a bit, eight bits is called a byte. A byte is the amount of space one letter takes up. One thing to bear in mind is that all the extra detail about how the letter looks must also be stored in binary code and so word processor documents use more space than one byte per letter.

7.1.4 Types of computers

There are many different kinds of computers. The ones that most people use are called **Personal Computers** (PCs). **Desktop PCs** are computers that you don't move around; they generally are a box with a monitor attached. Smaller, portable, computers that are about the size of a briefcase are called **laptops** or **notebooks**. There are also computers that are around the same size, but they have a special screen: **Text** (letters and numbers) is written directly on the screen, these are called **Tablet PCs**. They also do not require a mouse; the mouse gestures and clicks are done by tapping directly on the screen with your finger or with a **Stylus**. **Personal Digital Assistants** (PDAs) are computers so small that you can hold them in one hand. They generally also have a **Touch Screen**, like the Tablets. Notebooks, PDAs, and most Tablets have batteries so that you can use them without plugging into a wall outlet. These batteries generally last for about three to 8 hours , with some reaching 12 hours and beyond before needing to be recharged, although smaller devices may last longer. They use LCD screens because LCDs are thinner and take less power, so the batteries will last longer, and so that they are not, say, a foot thick. There are also much more powerful computers called **servers** that can be as big as a room or a house! This is what, say, Google and Wikimedia run their websites off of.

Type of Computer System	Image
Desktop Computer	
Laptop	
Tablet PC	
Personal Digital Assistant	

Server	
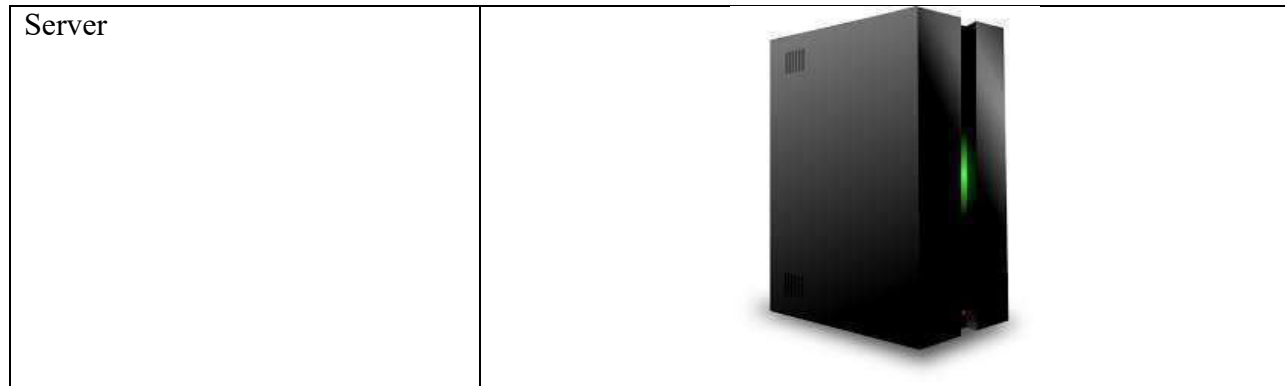
7.1.5 Turning the computer on

In a desktop, to start the computer first makes sure that the power supply is connected, and then presses the switch which is usually on the front of the computer. On laptops and tablets, simply locate the power button and press it. If it comes up, and it is like this one, you must type the correct **login name** and **password** in the respective boxes. If you get a picture (Windows 8+), then simply click it from the top. Then press the **enter** key, or **click** on (put the cursor on top of and push the left button on the mouse) the OK **button** if there is one. If the box does not come up, do not worry, nothing is wrong. That just means the computer is set not to have a password. We will learn more about this later. If this box did not come up, but instead a screen with pictures and names of the user accounts , click the picture with the correct user name beside it, type in the password (if there is one), and press(or tap) on your keyboard(or virtual) that says 'Enter'.
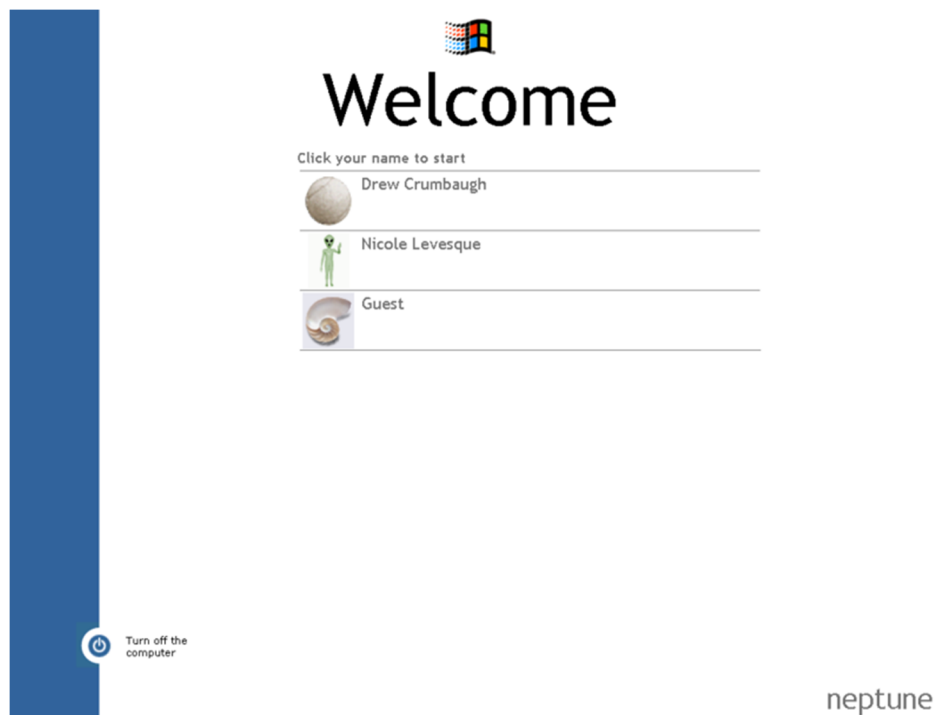
Figure 7.1: Login Screen in Windows

7.1.6 Turning off the computer

To turn the computer off:

Windows version	Method 1	Method 2	Method 3	Method 4
Windows XP (or earlier)	Open the Start menu, then click Turn off Computer, then click Shut Down.	Open the Start menu by clicking on Start or the Start orb located on the taskbar, then click Shut Down, then select Shut Down, then click OK.	Press Alt+F4, then select Shut Down, then tap or click OK.	Hold the power button for ~10 seconds
Windows Vista	Open the Start menu, then click the power icon.			
Windows 7	Open the Start menu, then click Shut Down.			
Windows 8	Open the Charms menu by either pressing Windows+C, moving the pointer to the upper or lower-right corner or swiping in from the right side of the screen. Tap or click Settings, then Power, then Shut Down.			
Windows 8.1		Right-click or long-tap on the Start logo located on the taskbar, then tap or click Shut Down.		

Other methods include:

1. **Windows 8.1 Update 1:** Open Start, then tap or click on the power icon located in the upper-right corner, then tap or click Shut Down. This method may not work on all devices.
2. **All Windows versions**: Open Command Prompt as an administrator. Type shutdown.exe /s and press Enter to run the command. This command can be used to shut down the computer after a specified time. To do so, type shutdown.exe /s /t x where x is the time to delay shutting down the computer in seconds. In Windows Vista or earlier, the maximum delay is 10 minutes. In Windows 7 or later, the maximum delay is 10 years.

7.2 OPERATING SYSTEMS AND CONTROLS

7.2.1 Software

Software is the set of instructions that tell a computer what it needs to do. There are two kinds of software: the System Software which includes the Operating System and Applications Software.

7.2.1.1 Operating System

Abbreviated OS, the Operating System is the resource manager which transforms sectors, bytes, interrupts and ports into files, folders, processes, and the user-interfaces with which you can interact. Examples include: Microsoft Windows (XP, Vista, or 7), any flavor of Linux, and Mac OS X (An apple version of UNIX).

7.2.1.2 Applications Software

Also called user programs, pieces of applications software do the specific things you want. The Operating System runs the computer and the Applications Software. It makes sure that the Hardware and the Applications Software understand each other. This makes it the most important piece of software on the computer. The Operating System also comes with utilities. These are pieces of Applications Software that mostly deal with managing data. You can also buy Third Party utilities, which means a different company made them than made the Operating System. Utilities Programs that manage, repair, and optimize data on a computer. A basic set comes with every OS. Applications Software does the specific things you want the computer to do, whereas the Operating System is general instructions to the computer for controlling the Hardware, Applications Software is specific instructions that work together with the Operating System to do work for you.

There are as many different kinds of Applications Software as there are things you could want to do with a computer; however the most common are word processing, spreadsheet, presentation, and database software and all computer games. Word processing software is used to create documents, which are formatted pages of text, such as letters, memos, reports or essays. Spreadsheet software organizes data, usually numbers, into columns and rows. It is used mostly for accounting and has many features for doing mathematical operations. Presentation software is used to make virtual (or, simulated) slide shows and usually have all sorts of exciting features for animations and sounds that you just can't do in a normal slide show. Database software is an advanced way of organizing complicated information in simple formats. A database is your electronic filing cst OS's and programs have the same features whether they use Windows or not, but all computers running Windows will have these features with these names. The thing we did in the last chapter with the box that comes up when you turn on your computer is called logging in. The screen you see after logging in is called the Desktop. Most things on a computer are named after things in real life, and they are usually used similarly too. Just like a real desktop the desktop on a computer is where you go to access all your data. However, a real desktop has a flat horizontal surface. You can replace the Operating System with another whether or not your system gets a virus. The most common replacement Operating System is called Linux. It is free to download and install and software for it is freely available via the Internet.

Desktop The desktop is the area that appears right after logging in. It contains a background picture (wallpaper),icons and the taskbar. On the desktop are pictures with text labels under them, these pictures are called icons because they represent something else. If you move or get rid of an icon, all that means is that you have to access what they represent a different way, you

haven't gotten rid of the application software the icon is representing. Icons usually represent programs, but sometimes they represent collections of data. Double-clicking (clicking twice in rapid succession) on one of these icons will open whatever it represents, the text tells you what it represents.

Icons A tiny picture that represents a program, folder, or program function.

There is a bar that is usually at the bottom of the desktop, however it may also be on any other side. If you cannot see it, then move the cursor to the edge where it is and it will come up. It is called the task-bar.

Taskbar The taskbar is the bar along one side of the desktop. It is used for launching programs or opening the window of an open program.

Along the main part of the task-bar is a list of all open programs, clicking on one element of this list will put that program's window (the box that a program is viewed in) on top of all other open windows. Over on one side of the task-bar is a clock; beside the clock are a bunch of icons that represent open 'invisible' programs. These are programs that are always running and do things 'behind the scenes'. This area is called the system tray. On the main part of the task-bar there is sometimes a small group of icons, this is called the quick-launch bar. Clicking on one of these icons opens whatever it represents.

System Tray The system tray holds icons for programs currently running 'behind-the-scenes'. On the opposite side of the task-bar from the clock and the system tray is a button. A button (or command button) is just like a real button, when it is pushed (clicked) it does something. Some buttons have text on them that say what they do, and some have icons representing what they do. Some have both.

(Command) Buttons Buttons do something when you click on them. They may be labeled by text, an icon, or both. The quick-launch icons are also buttons. Some buttons are raised to look like real buttons and some only raise up when you hover (put the cursor on top of) them. The button on the other side of the start-bar from the clock and system tray is called the start-button. When you click the start-button it opens the start-menu. The start-menu has icons for more programs and data collections, although it is usually programs.

Start button The Start button is a button that opens the start-menu.

Start menu The Start menu contains icons for all installed programs and data collections, usually for programs.

The icons that are on the desktop, the quick-launch bar, and the start-menu are usually shortcuts.

On the desktop shortcuts are often indicated by a small symbol on top of the icon ( ). Shortcuts are what I meant earlier when I said 'if you move or get rid of an icon, all that means is that you have to access what they represent a different way, you haven't gotten rid of the actual thing'. Icons represent all data collections and programs even if they are not shortcuts, however normally the ones on the desktop and in the start-menu are shortcuts.

Shortcuts Icons that are only links to the things those icons represent.

The difference between icons and shortcuts is important so be sure you understand it. An icon is any picture that is meant to convey what something is. The icon on the start-button represents the

fact that it is a major part of Windows, which is why it is a Windows logo. Shortcuts are a link to a program or data collection; the icon on a shortcut represents whatever the shortcut opens, however the same icon would be on the real thing as well. You open whatever is linked to by each shortcut on the start-menu by clicking on it. If any icon has a right-arrow beside it, then hovering over it or clicking on it will make a sub-menu (a menu inside a menu) come out with more shortcuts on it.

Everything we just talked about is part of the Windows interface. An interface is just anything that goes between two or more things. This interface goes between you and the computer, you could also say that the Operating System is the interface between the hardware and software.

Interface An interface, just as the name suggests, is anything that acts as or creates a medium of interaction or communication between multiple things. A user-interface is the means of interaction between (you)the user and the computer.

There are some standard things that are on most user-interfaces. We have already talked about one, buttons. These things are called **controls**. Below is a table of some of the more common controls, starting with buttons:

Name of control and picture	Description
(Command) Button	Buttons (also called command buttons) do something when clicked.
Check box	A check box turns something on or off. There is a check in the box if it is on, to change it click on it.
Text box	Also called edit boxes, these boxes let you type text in them.
Radio button	Also called option buttons, these boxes come in groups, you can only pick one per group.
List box	These boxes contain lists of things: you can select one.
Combo box	Also called drop-down boxes, these boxes are like text boxes, but they have a button on the side that, when clicked, brings up a list of things that you can pick from.
Spin button	These buttons increase or decrease numerical values by one when the up or down arrow half is clicked.
Scroll bar	Click on the arrows at the top and bottom of these bars to move the screen, you can also drag the box that is on the bar.
Label	Often overlooked, labels don't do anything, but they sit near other controls with text in them to tell you what those things are.

You can get a basic description of what any control does by hovering your mouse over it. A little thing with text will pop up. This is called a **tool-tip** (or a **ToolTip**).

Besides these there are also **menu**s. Menus all operate the same way as the start-menu. Some of them are found at the tops of programs. These are called **main-menus** or simply menus. Other menus are opened by **right-clicking** (pushing the right mouse button over something). These are called **popup-menus**.

7.3 THE DESKTOP

There are no 'real' layers though; you can't peel off the wallpaper and see the Desktop! However there are 'virtual' layers, arranged with the Desktop on the bottom. What you see behind the icons on the Desktop is called the wallpaper, whereas the whole thing is the Desktop, not just the picture/colour that you see behind the icons. Application windows are layered on top.

You can add shortcuts to your Desktop in a number of ways. The most common way is to right-click on the desktop, which brings up the popup-menu. On the popup-menu there should be a sub-menu labelled 'New', hover over this. When the sub-menu pops out find the item labelled 'Shortcut' and clicks it. A dialogue-box will come up asking you where the program or data collection is found. Later we will get into how to form something to type in the box; however it is easier to just click the button beside labelled 'Browse...'

The Browse button is a standard button that you will see often; clicking it always brings up a dialogue-box in which you can select programs and data collections. Select the program or data collection you want to make a shortcut to and click the button labelled 'OK'. The OK button is also a standard button on dialogue-boxes that you click to tell it that you are done filling in information and it can use that data now. 'OK' is usually paired with 'Cancel', 'Cancel' closes the dialogue-box without doing anything.

When you have selected the correct program or data collection click the button marked 'Next >'. The Next button is, again, a standard button that tells the dialogue box you are done this step and to go on to the next step in the process. It usually comes with the Back button to go to the previous step. This dialogue-box also has a Cancel button. After you have clicked 'Next' the dialogue-box comes up with a text-box asking what you want the text under the icon to be for this shortcut. When you have typed what you want into the box click 'Finish', another standard button.[1]

If you do not like the text under a shortcut, you can change it. There are three primary ways to do this. The first one is to click on the shortcut, selecting it, and then push the 'F2' key on your keyboard. The text will become a text-box that you can type in to change what it says. The second way is to right-click on the shortcut, bringing up its popup-menu, and select 'Rename' from the popup-menu. The same thing will happen. Another way to cause it to happen is to select

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[1] NOTE: The true name of these buttons is above in bold. However it is common computer shorthand to say Click 'OK' instead of Click the OK button. We will be using this shorthand in this book.

the icon and then click on it. Do not double-click! That will open whatever it links to, select it and then click.

If you want to change the icon (picture) one your shortcut, bring up its popup-menu and select 'Properties'. Across the top of the window, just below the bar with the 'X' button on it (the title bar), there are a bunch of tabs, click the one labelled 'Shortcut'. Then, click the button labelled 'Change Icon…', in the dialogue-box that comes up select the new icon that you want, or click 'Browse' to find more files with icons. In this same window where the 'Change Icon' button is, there is a text-box labelled 'Target:'. It is the same as the box with a Browse button on the first step of adding a shortcut to the Desktop, only there is no browse button. That it what you change if you want the shortcut to link to something else.

You can also move or sort icons on the Desktop. To sort them right-click on the Desktop and hover over the sub-menu called 'Arrange Icons By'. Then click on the way you want them sorted. If you want them automatically sorted make sure the 'Auto Arrange' option is checked (you can check or uncheck it by clicking on it). If you have Auto Arrange off, you can put the icons wherever you want them. Click on one and don't let the button go back up. Move the cursor over to where you want the icon to be and it will move right along with it. When you have it where you want it, let go of the mouse button. This is called dragging-and-dropping.

If you want to take an icon off the desktop there are three major ways to do it. You can select the icon you want to remove and push the 'Delete' key on your keyboard. A dialogue-box will come up, click 'Yes'. You can also drag-and-drop the icon onto the recycle bin, which is an icon on the Desktop labelled exactly that. Or you can right-click on the icon and click 'Delete'. The same dialogue-box will come up for you to click 'Yes' on. If you did it by accident you can click 'No' and it won't remove the icon.

There are other settings you can change on the Desktop. To access them right-click on the Desktop and select 'Properties' from the popup-menu. To change the wallpaper select the tab labelled 'Wallpaper' or 'Desktop'. To change what picture is displayed for wallpaper select it from the list or if it is not in the list click 'Browse…'. There is a combo box from which you can select whether to stretch, tile (repeat by picture with itself together likes tiles), or centre the picture. If you just want a colour for your wallpaper, then select '(None)' from the list. Sometimes there is a combo-type box to select the colour right there and sometimes you have to change it under the 'Appearance' tab.

You can also change the Screen-Saver. The Screen-Saver is a program that shows up after your computer has not been used for so long so that the monitor will not get wrecked (which can happen if the same picture is displayed on it for hours at a time). To change the Screen-Saver click the tab labelled 'Screen-Saver'. There will be a combo box that lists all the Screen-Savers on your computer. After you have selected the one you want you can change how long the computer waits before bringing it up in the text box with a spin button that is below the combo box.

You can also change the colour scheme of all the controls in almost all programs. Click the 'Appearance' tab. There is one or more combo boxes on this page that allow you to select

different combinations of default colour schemes. On this same page, or sometimes you have to click 'Advanced' to get there, are other settings. You can select an element from one combo box, and then change it's colour and how its text looks. You can try experimenting with this if you want, just be sure to save your current settings so you can change back (which some versions of windows don't allow, so don't worry then). You do this by clicking the 'Save As…' button and typing the name you want to call the colour scheme.

There is one final tab common to most versions of Windows. It is the 'Settings' tab. It is not recommended to change settings in this tab unless you know what you are doing. Some games will give errors when you try to start them like '256 colours required' or 'This program needs 640 × 480 to run'. This is where you set those. There is a combo box here, selecting a different option from this box changes the number of colours your computer can display. More colours mean more quality. There is also a slider labelled 'Screen resolution'. It increases or decreases the size of everything displayed on your monitor. The larger the numbers, the smaller things are, and the smaller things are the more you can fit. When this is set to make things smaller, some programs (or you can manually) change their stuff so that it looks the same size, allowing them to have more quality in display.

7.4 SUMMARY

1. A **computer** is an automatic, electronic, data-processing machine that takes in facts and figures known as **data**, and then **processes** or organizes it in some useful way. Afterwards it **outputs**, or displays, the results for you to see as information.
2. Hardware refers to all of the physical components of a computer.
3. Software is all of the instructions and programming that a computer uses to do what you ask it to do.
4. There are two kinds of software: the **System Software** which includes the Operating System and **Applications Software**.
5. Operating System is the resource manager which transforms sectors, bytes, interrupts and ports into files, folders, processes, and the user-interfaces with which you can interact.
6. Applications Software, also called user programs, pieces of applications software do the specific things you want.
7. An interface is anything that acts as or creates a medium of interaction or communication between multiple things.

7.5 REFERENCES

Figures

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UNIT 8: INTRODUCTION TO MS WORD

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8.0 LEARNING OBJECTIVES

At the end of this unit, you should be able to:

1. Open and View a word document.
2. View Non-printing characters in a word document.
3. Type and correct texts in a word document.
4. Save a word document.
5. Open files in the word application.

8.1 STARTING UP WORD: ON YOUR MARKS, GET SET, GO!

Are you relaxed and sitting comfortably? Did you come with a desire to learn? Then I'd like to begin by showing you how to start up Word!

8.1.1 Starting Word

Ready? Then I'll show you how to start Microsoft Word:

1. Click the Start button - the Start menu appears.
2. Point to the entry for All Programs.
3. Click on the entry for Microsoft Office – Word 2007
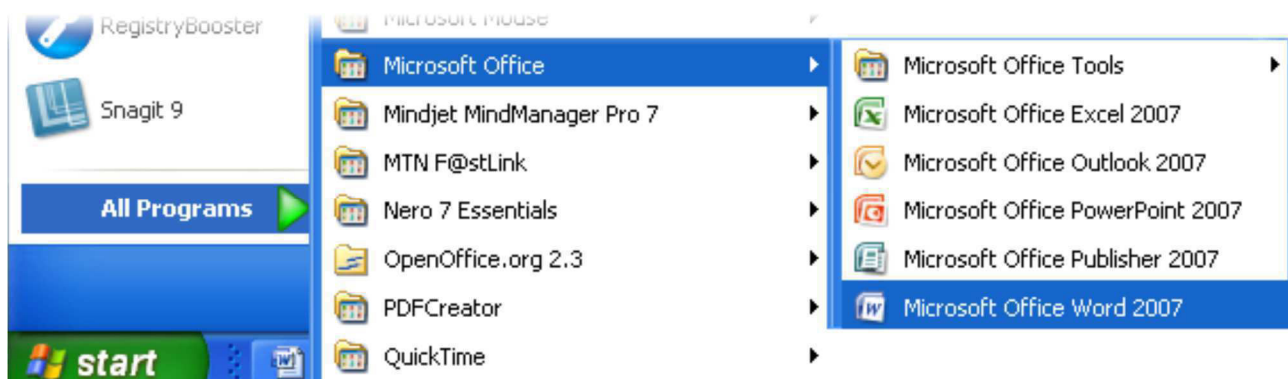
The Microsoft Word program will load, and a blank document will appear on your screen.

8.1.2 When you need help

At the top right corner of your MS Word screen, you'll see a small blue circle containing a question mark; just click on the question mark to open the MS Word Help window. You can also access the Help window by pressing the [F1] key on your keyboard. To get help on a specific topic, type a word or phrase in the blank area at the top of the window and then click the Search button; alternatively, you can click on any of the Help topics listed in the window. Click the X in the top right corner to close the Help window.
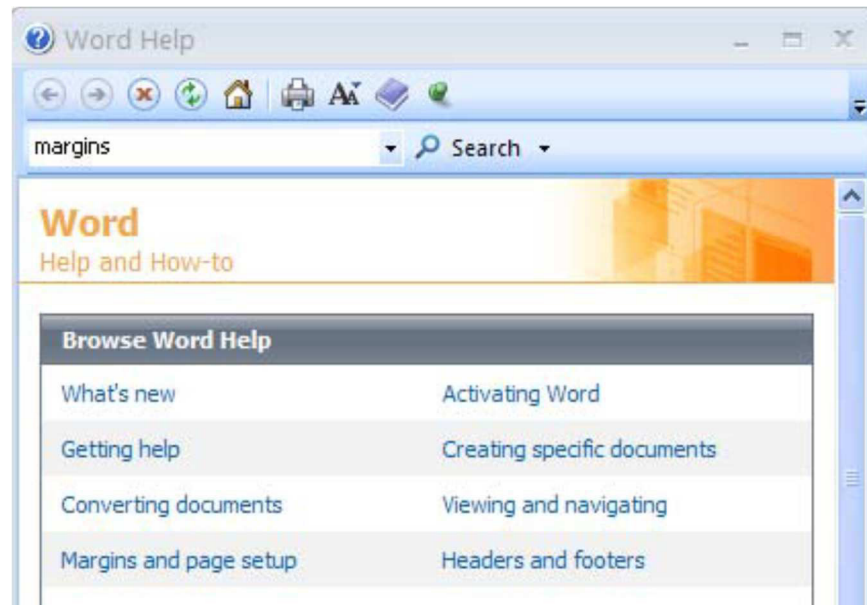
8.2 AN OVERVIEW OF WORD

Now it's time for an overview of Word 2007!

8.2.1 The MS Word 2007 window

If you've used previous versions of Word, you'll notice that the old menu system has been replaced by the Ribbon and the Office button.
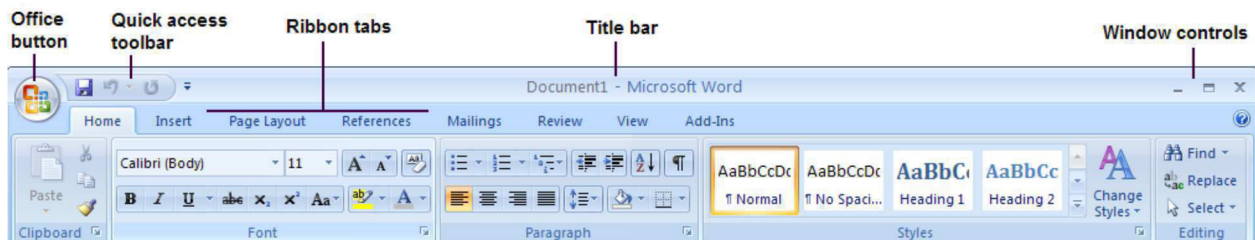
- The Office button contains a menu of file-related commands. Click the Office Button to see the available commands. Select a command by clicking on it.
- The Quick access toolbar provides a set of frequently used commands. The default options are to save a file, to undo the last action, and to repeat your most recent action.
- The Ribbon tabs provide you with a set of tools that are relevant to what you are currently doing. In the example above, the Home tab contains formatting and editing options.
- The Title bar displays the name of the program and the name of the current document. If you haven't named the document yet, then it will be called something like Document1.
- Window controls are used to change the size of a window, or to close it.

Some standards that help to give your documents a professional look and feel are the following:
- a regular font style and size used for headings, subheadings and regular text
- the content, position and structure of the page headers and footers
- the position of your personalised logo on the document.

Apply these standards consistently throughout your document. This will add to the aesthetic appeal of the document and will also minimise confusion.

Your document will also be easier to maintain if you DON'T
- Use tabs to indent a paragraph
- Use spaces to align columns of text
- Use blank lines to leave space at the end of a page

Vertical scrollbar

Status and information bar

Section: 1   Page: 1 of 1   Words: 278   ✓   100%

- The Vertical scrollbar is used to scroll up and down the page. You can also click on the little down arrow below the scrollbar to move down the page. If your page is wider than the screen display, then you will also see a Horizontal scrollbar across the bottom of the window.
- The Status and information bar displays useful information about your document, such as the page count and number of words.

8.2.2 Options for viewing a document in Word

Word offers you five different views of your "virtual piece of paper":
- Print layout
- Full screen reading
- Web layout
- Outline view
- Draft view

For our purposes, Print layout is the best document view to work with. In Print layout, the piece of paper on your screen looks almost exactly as it will appear when printed. You'll be able to see precisely where the page breaks and the edges of the paper fall. It's easy to switch between the different page views:

1. Look at the right end of the status and information bar at the bottom of the window. Here you'll find a set of five miniature buttons.
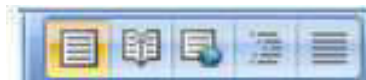
2. The Print layout button is the first button on the left.
3. You can click on any of the other buttons to change to the corresponding view.

8.2.3 Showing non-printing characters

Non-printing characters are characters that are used to format your document, but that aren't displayed as text on your screen. For example, when you press the [TAB] or [ENTER] key, a formatting character is stored at the corresponding point in your document. Here's how to display the non-printing characters in your document:

1. Click the Show/Hide ¶ button on the Home ribbon.
2. Now the non-printing characters will appear in your document. Each time you press [ENTER], you'll see the paragraph symbol ¶ Spaces are indicated by dots · The [TAB] key is indicated by a small arrow →

```
¶
Your·document·will·also·be·easier·to·maintain·if·you·DON'T¶
    •→ Use·tabs·to·indent·a·paragraph¶
    •→ Use·spaces·to·align·columns·of·text¶
    •→ Use·blank·lines·to·leave·space·at·the·end·of·a·page¶
¶
```
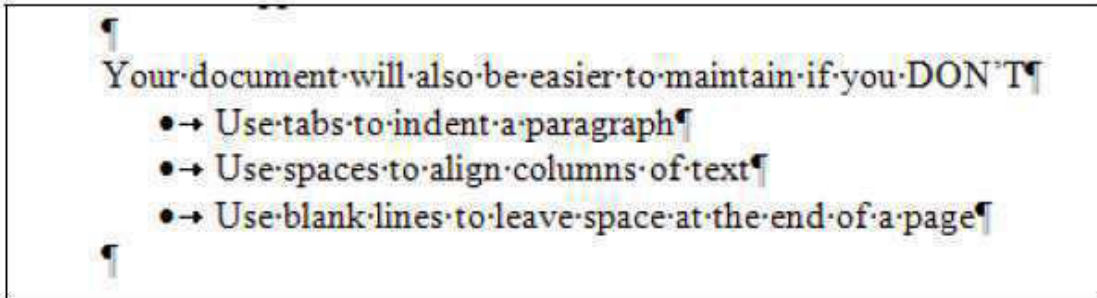
3. Click the **Show/Hide** button ¶ again to hide the non-printing characters from view.

8.3 WRITING RIGHT AWAY – SOME IMPORTANT BUTTONS AND GUIDELINES

When you start Word, you effectively roll a new, empty page into your Word "typewriter". In addition, the cursor (the writing-mark) blinks contentedly and waits for your text. So what are you waiting for then? Start typing! Write down whatever comes into your head!

8.3.1 Typing upper-case letters

You want to type UPPER-CASE letters? Just hold down the [SHIFT] key, and type the letters that you'd like in upper case. You'll find the [SHIFT] key in two places on your keyboard.

Are you typing only upper-case letters? Then you probably pressed the [CAPS LOCK] key by mistake. It's usually located just above the [SHIFT] key on the left-hand side. To deactivate this function, simply press [CAPS LOCK] again.

On most keyboards, you'll recognise such "toggle keys" immediately, since they control a series of little lights (usually green) on the upper right side of your keyboard.
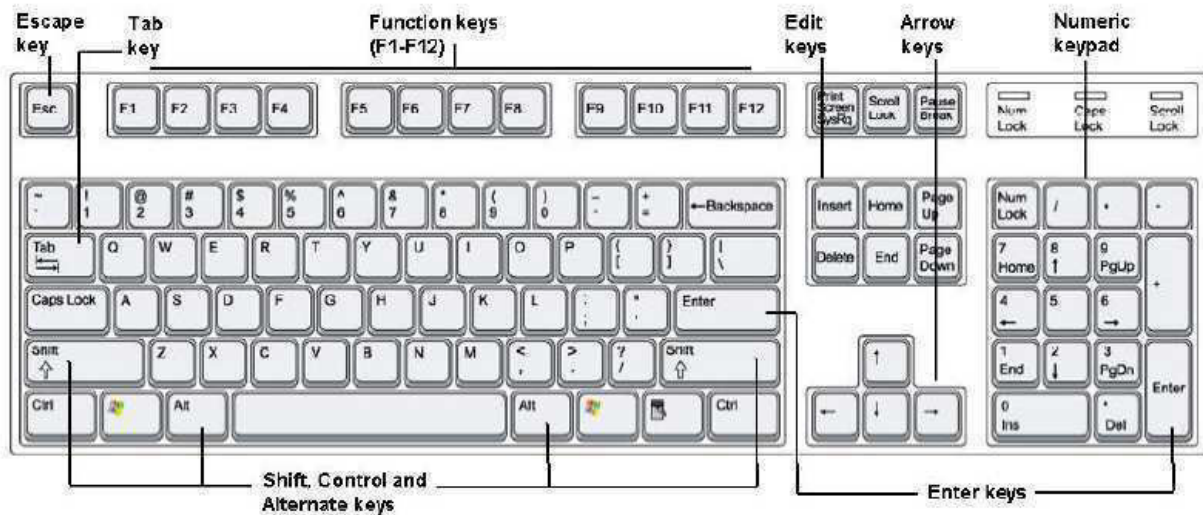
8.3.2 Rules for entering text

Please type the following text. Do not press [ENTER] until the end of the paragraph.

> This is a short note to tell you briefly about my experiences on my first day at university. I was very excited but I was also a bit scared and wasn't sure whether I was going to find my way around. In fact it all went very well. There were lots of people I could ask, and all the other new students were just as confused. I am still having a problem finding all my lecture venues though.

You'll notice that in Word, line breaks occur automatically. You should only press [ENTER] if you really want to start a new paragraph. You'll also press the [ENTER] key if you want to move on to a new line after writing only a few words. For example, you might want to do this if you're making a list or typing a short passage of text. Whatever you do, don't press [ENTER] after each line of continuous text! That makes it very difficult to edit your writing. But do leave a space after every punctuation mark – that is, after full stops, commas, or exclamation marks.

8.3.3 Correcting mistakes

You made a mistake? That's not so bad! There is a wonderful key that helps you correct your mistakes, called the [BACKSPACE] key. You'll find it directly above the [ENTER] key. Each press of the [BACKSPACE] key deletes one character to the left of the cursor.

8.3.4 Undoing steps

Instead of erasing one word, you'd like to undo several steps at once? No problem!

1. Each press of the Undo button (on the Quick Access toolbar) takes you one step backwards.

2. If you click the little down arrow next to the Undo button, you'll see a list of all the steps you've taken so far. Using this list, you can select the specific step(s) that you want to undo.
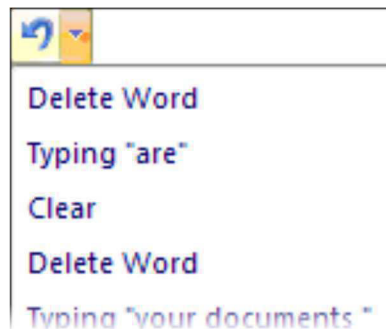
8.3.5 Safety first: saving documents

Hey! You're writing and writing, but have you saved your document? Currently the document exists only in your computer's memory, which means that it could get lost at any second. Your computer's memory is a fleeting electronic storehouse. If there's a power failure, or your computer crashes (the system hangs), then all the data in memory will be lost! The solution to the problem? Save your work as soon (and as often) as you possibly can.

8.3.6 Saving data for the first time

Here's what to do if you're saving a file for the first time:

1. Click the Save button on the Quick Access toolbar . You'll recognise it by the picture of a diskette on it.
2. The Save As window will appear.
   Normally, the MY DOCUMENTS folder is already selected. This is NOT where you are to save! The MY DOCUMENTS folder is on the C: drive, and to prevent it accumulating files for lots of students, it is cleared out daily. (Even if it wasn't cleared out, to access it you would have to use the exact same computer every time you wanted to work on a file.)
3. Instead, click the drop-down arrow next to Save In.
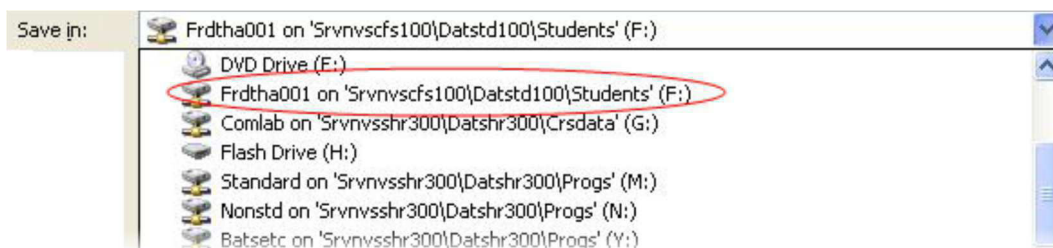
4. Click on the drive (F:) that shows your student number.
5. Now look at the File name field. Word has already entered a placeholder name for you, usually based on the first few words that you typed. But you don't want this name!

6. Overwrite the placeholder name by typing your own file name in the field, eg My First File.

7. Click the Save button. Your document will be saved with the name you gave it, in the F: drive that you selected. Note that the new file name is now displayed on Word's title bar.

8.3.7 Saving regularly

Now you've saved your file for the first time, but that's not enough! You need to keep saving your work at regular intervals.

1. To save, click the Save button on the Quick Access toolbar from time to time.
2. Or you can use the keyboard shortcut: press [CTRL] + [S].
3. Your file will be saved without a lot of fuss.

Why doesn't the first dialogue box appear anymore? The answer to this question is simple. You gave the file a name and specified its location the first time you saved it. Now Word just saves the file under the same name and in the same place!

8.4 USING FILES AND FOLDERS

8.4.1 Opening your documents

You'd like to work more on a document that you previously started? Just open the appropriate folder and haul your work out again. There are two different approaches you can use for opening existing Word documents. To open a document directly from Word:

1. Click the Office button. A list of your most recent documents is displayed on the right of the file menu. Click any file name to open it.
2. If the file you want is not on the list, then select the Open command. The button looks like a folder that's being opened.

3. The Open dialog box will appear.
   a. Click on the down arrow beside the Look In field and select the file location (probably your F: drive).
   b. Then choose your file by clicking its entry on the list.
4. Click the Open button in the lower right corner of the dialog box. Alternatively, you can double-click on the file name to open it.

5. The contents of your file will be displayed on the screen. Note that several documents can be open simultaneously – just repeat this process.

To open a document from inside My Computer:

1. Select MY COMPUTER from the Start menu or by double-clicking its desktop icon.

2. Double-click on the drive containing the required folder and file (this could also be a flash drive).
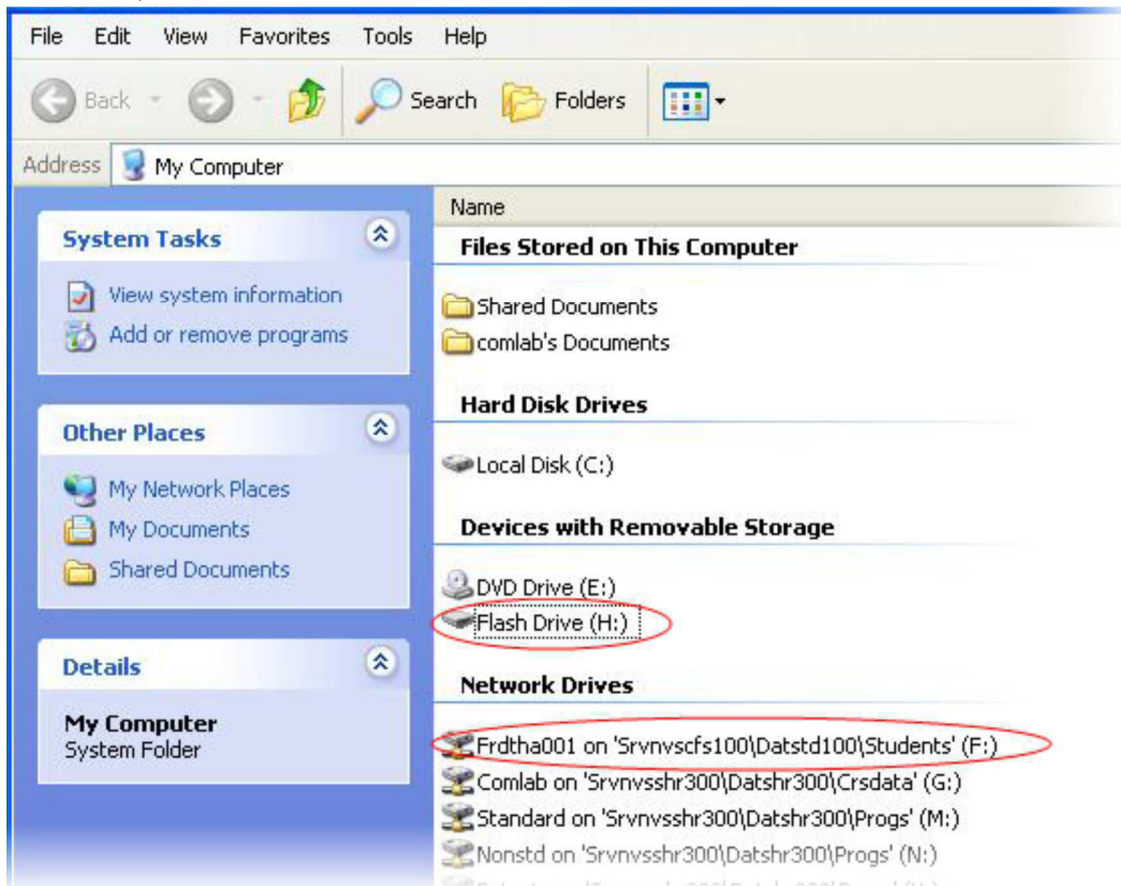
3. Double-click the folder you saved your document in, to see the files that it contains.
4. Double-click the required file name, or else select it and press [ENTER]. The file will open in Word.

8.4.2 A new empty document

You need a new, empty document? Nothing could be easier! If you already have a document open on your screen, then you don't even have to close it (although this might be a good time to save it!).

1. Click the Office button and select the New option, followed by Blank Document.

2. Alternatively, you can select the Insert tab on the ribbon and click the Blank Page button on the extreme left. You'll recognise it by the icon of a dog-eared white page.
3. A new "sheet" will appear in your Word typewriter. Look at the title bar. You'll know the new document by its placeholder file name, for example Document2.
4. In addition, if you look at the Windows taskbar at the bottom of the screen, you'll see a new button for your new document.

Don't forget to save your new document with your own file name, and in the correct location! If you'd like to move from one document to another, then all you have to do is to click the corresponding button on the Windows taskbar.

8.4.3 Creating a new folder

You'd like to have a new folder in which you can save your work? You can create a new "data area" even from within Word. You do this using the Save As dialog box.

1. Click on the Office button and select the Save As option.
2. Click the Create New Folder button.

3. Now you'll see a dialog box where you'll name your new folder. Type the new name in, for example Training.
4. Click OK.
5. Great service! Word will automatically switch over to your new folder.
6. Give your file a name (the previous name that you entered was the folder name) and click on the Save button.

8.4.4 Save or Save As?

By now you've probably noticed that the Office button offers you both a Save and a Save As command. So what's the difference? Well, when you save a file for the first time, it makes no difference whatsoever! Really – it doesn't matter whether you click on the Save icon, or whether you select Save or Save As from the Office button. Word will display the Save As dialogue box so that you can specify a file name and location. Only if you save the file again will you notice a difference:

- If you want to keep the same file name and location, then the Save icon and the Save menu option will both save the file with no further comment.
- If you'd like to save an existing document under a new name, or in a different location, then you need to use the Save As command. This will display the Save As dialogue box so that you can specify another file name and/or a new folder.

8.4.5 Saving a file on to a flash drive or diskette

Would you like to save your file to a flash drive or diskette? You might want to do this to make a backup copy, or to continue working on your file using another computer.

WARNING: you should never save your documents *only* on a diskette or flash drive. These can be easily corrupted and your data may be lost. It's safer to store your work on the network drive.

I'm assuming that you want to save a document that's already been saved to the network drive, and so it already has a file name. Here's what to do:

1. Click the Office button and select the Save As command.
2. In the dialog box, click the down arrow next to the Save In field.
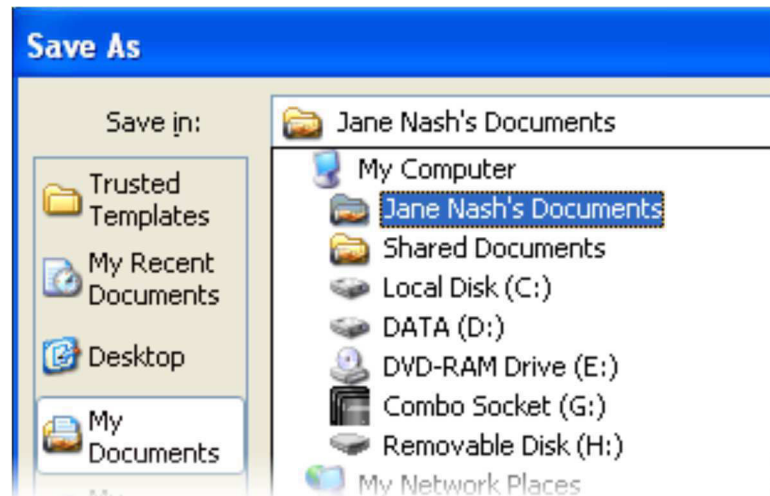
3. From the list, select the device on which you want to save your file.
    a. Stiffy disk drives are typically drive A:.
    b. Flash drives have a letter allocated by the operating system, and may be labelled by the device name or as a Removable Disk.
4. Click the Save button.

8.4.6 Closing a document

You'd like to close the current document without quitting Word?

*   Just click the Office button and select the Close command

You'll see the Word screen without any document.

8.4.7 Closing Word

There are several methods you can use to end Word:

*   Click the Office button, and then click the Exit Word button in the bottom right corner.
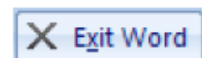
*   Alternatively, close the window by clicking on the X at the far right edge of the title bar.

If you've made any changes since you last saved your document, then you'll be asked whether you want to save your changes. You can return to your document by pressing [ESC] or clicking the Cancel button.
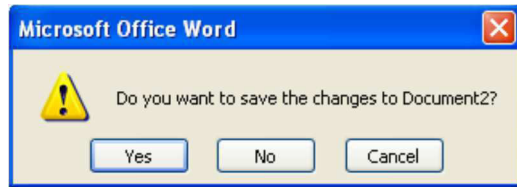
8.5 REFERENCES

Centre for Educational Technology, U. o. (2009). *Introduction to MS Word 2007*. Retrieved Oct. 18, 2017, from

https://vula.uct.ac.za/web/learnonline/manuals/CET%20MS%20Word%202007%20Training%20Manual%20v1.2.pdf available under creative commons attribution license.

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UNIT 9: INTRODUCTION TO MS EXCEL 2007

9.0   LEARNING OBJECTIVES

9.1   GETTING STARTED WITH EXCEL

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    9.1.2 THE EXCEL 2007 WINDOW

    9.1.3 STARTING EXCEL

    9.1.4 CLOSING EXCEL

    9.1.5 NAVIGATING WITHIN A WORKSHEET

    9.1.6 SELECTING CELLS

    9.1.7 SELECTING ROWS OR COLUMNS

9.2   ENTERING DATA

    9.2.1 FIRST YOU NEED A WORKBOOK

    9.2.2 OVERVIEW OF DATA TYPES

    9.2.3 DATA ENTRY CELL BY CELL

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    9.2.6 COPYING DATA

    9.2.7 USING AUTOFILL

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9.3   REFERENCES

9.0 LEARNING OBJECTIVES

At the end of this unit, you should be able to:

1. Define excel.
2. Open an excel document
3. Close an excel document
4. Navigate within a worksheet
5. Select a cell in an excel document.
6. Select rows and columns in an excel document.
7. Enter the data into a cell.
8. Understand various data types available in excel.
9. Move data among cells.
10. Copy data between cells.
11. Use autofill feature.
12. Save a workboos.

9.1 GETTING STARTED WITH EXCEL

Excel and Word have a lot in common, since them both belong to the MS Office suite of programs. This means that if you are familiar with Word, then you already know how to use several Excel features!

In the Word section of this manual, you'll be able to find more information and guidance on

- Using the mouse and keyboard
- Starting the program
- The Office button and ribbon
- Character formatting
- Opening, saving and printing files
- Accessing Help

9.1.1 What is Excel?

Excel is all about numbers! There's almost no limit to what you can do with numbers in Excel, including sorting, advanced calculations, and graphing. In addition, Excel's formatting options mean that whatever you do with your numbers, the result will always look professional!

Data files created with Excel are called workbooks (in the same way as Word files are called documents). But where Word starts up with a single blank page, Excel files by default contain three blank worksheets. This gives you the flexibility to store related data in different locations within the same file. More worksheets can be added, and others deleted, as required.

You'll often hear Excel files referred to as spreadsheets. This is a generic term, which sometimes means a workbook (file) and sometimes means a worksheet (a page within the file). For the sake of clarity, I'll be using the terms workbook and worksheet in this manual.

9.1.2 The Excel 2007 window

As in Word 2007, the old menu system has been replaced by the Ribbon and the Office button. The title bar displays the name of your current workbook. Tabs at the bottom of the screen identify the different worksheets available to you – I'll show you a little later how to give them meaningful names.

Notice how the working area of the screen is divided into rows (1, 2, 3, 4, ...) and columns (A, B, C, D, …). Together these provide an address, such a C10 or G21, that uniquely identifies each cell in the worksheet. A range of cells extends in a rectangle from one cell to another, and is referred to by using the first and last cell addresses separated by a colon. For example, the group of cells from A3 to G4 would be written as A3:G4.

In the example above, the current or active cell is B7. It is surrounded by a heavy black border, and its address is displayed in the name box above column A. Its row and column numbers are also highlighted.
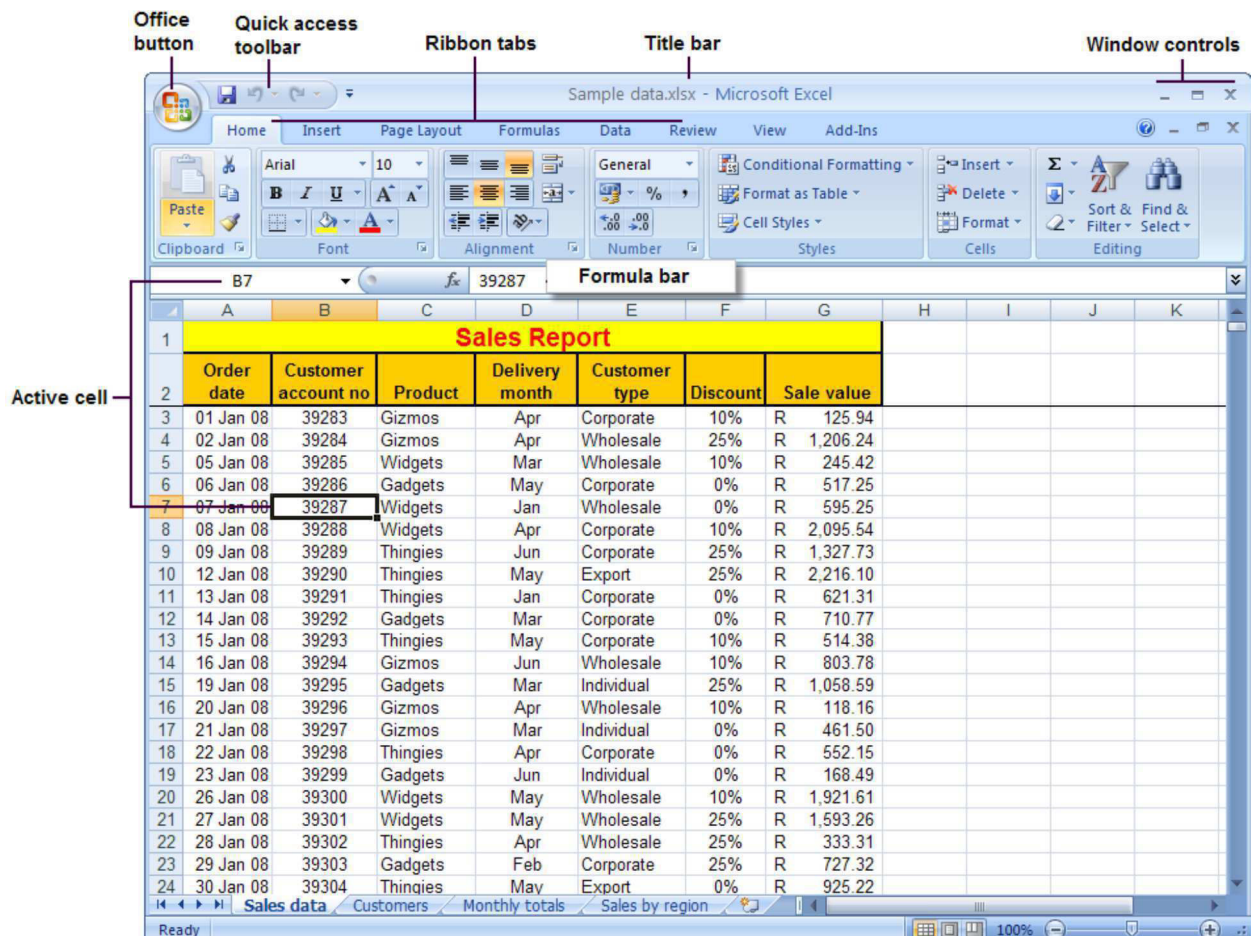
On the right of the name box is the formula bar. This displays the value stored in the active cell, and is also the place where you would enter a new data value or formula into that cell.

9.1.3 Starting Excel

If you have an icon on the desktop for Excel, then all you have to do is double-click it to open Excel.
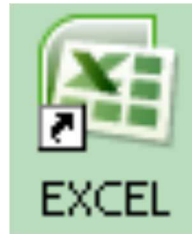
Alternatively, click the Start button and then select All Programs, Microsoft Office, Microsoft Excel.
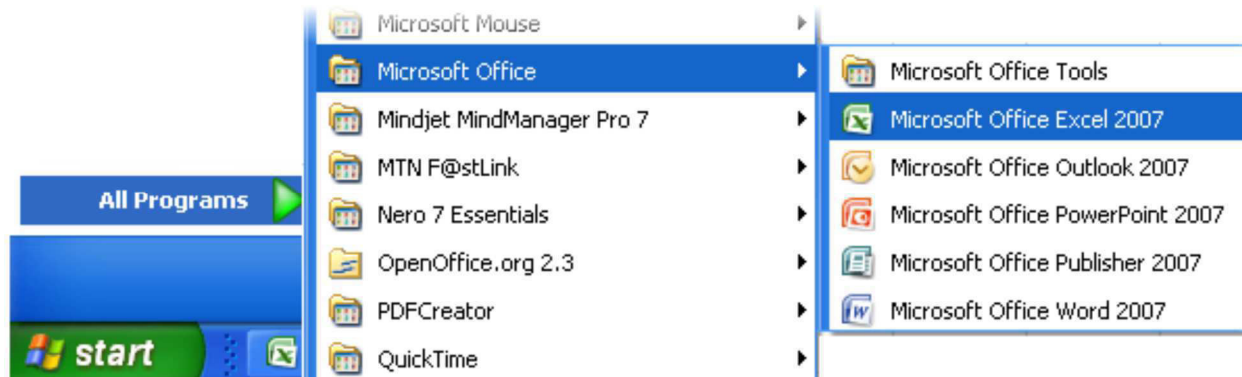
- When you open Excel from a desktop icon or from the Start menu, a new empty workbook (consisting of three worksheets) will be displayed on your screen.
- If you double-click on an existing Excel file from inside the Windows Explorer window, then Excel will open and display the selected file on your screen.

9.1.4 Closing Excel

Close Excel by clicking the X on the far right of the title bar.

9.1.5 Navigating within a worksheet

Using the mouse:
- Use the vertical and horizontal scroll bars if you want to move to an area of the screen that is not currently visible.
- To move to a different worksheet, just click on the tab below the worksheet.

Using the keyboard:
- Use the arrow keys, or [PAGE UP] and [PAGE DOWN], to move to a different area of the screen.
- [CTRL] + [HOME} will take you to cell A1.
- [CTRL] + [PAGE DOWN] will take you to the next worksheet, or use [CTRL] + [PAGE UP] for the preceding worksheet.

You can jump quickly to a specific cell by pressing [F5] and typing in the cell address. You can also type the cell address in the name box above column A, and press [ENTER].

9.1.6 Selecting cells

Using the mouse:
- Click on a cell to select it.
- You can select a range of adjacent cells by clicking on the first one, and then dragging the mouse over the others.
- You can select a set of non-adjacent cells by clicking on the first one, and then holding down the [CTRL] key as you click on the others.

Using the keyboard:
- Use the arrow keys to move to the desired cell, which is automatically selected.
- To select multiple cells, hold down the [SHIFT] key while the first cell is active, and then use the arrow keys to select the rest of the range.

9.1.7 Selecting rows or columns

To select all the cells in a particular row, just click on the row number (1, 2, 3, etc) at the left edge of the worksheet. Hold down the mouse button and drag across row numbers to select multiple adjacent rows. Hold down [CTRL] if you want to select a set of non-adjacent rows.

Similarly, to select all the cells in column, you should click on the column heading (A, B, C, etc) at the top edge of the worksheet. Hold down the mouse button and drag across column headings to select multiple adjacent columns. Hold down [CTRL] if you want to select a set of non-adjacent columns.

You can quickly select all the cells in a worksheet by clicking the square to the immediate left of the Column A heading (just above the label for Row 1).
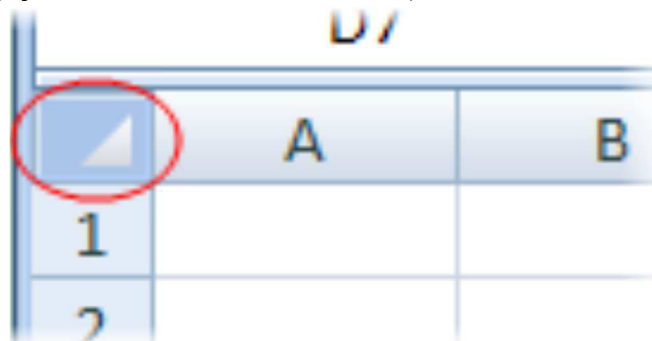
9.2 ENTERING DATA

9.2.1 First you need a workbook

Before you start entering data, you need to decide whether this is a completely new project deserving a workbook of its own, or whether the data you are going to enter relates to an existing workbook. Remember that you can always add a new worksheet to an existing workbook, and you'll find it much easier to work with related data if it's all stored in the same file.

If you need to create a new workbook from inside Excel:

1. Click on the Office button, select New and then Blank Workbook.
2. Sheet 1 of a new workbook will be displayed on your screen, with cell A1 active.

To open an existing workbook from inside Excel:

1. Click on the Office button, click Open, and then navigate to the drive and folder containing the file you want to open.
2. Double-click on the required file name.

9.2.2 Overview of data types

Excel allows you to enter different sorts of data into the cells on a worksheet, such as dates, text, and numbers. If you understand how Excel treats the different types of data, you'll be able to structure your worksheet as efficiently as possible.

*   **Numbers** lie at the heart of Excel's functionality. They can be formatted in a variety of different ways – we'll get to that later. You should generally avoid mixing text and numbers in a single cell, since Excel will regard the cell contents as text, and won't include the embedded number in calculations. If you type any spaces within a number, it will also be regarded as text.

2	✗	VAT @ 14%		text and numbers mixed
3	✓	VAT @	14%	text and numbers in separate cells

    Note that dates and times are stored as numbers in Excel, so that you can calculate the difference between two dates. However, they are usually displayed as if they are text.
    If a number is too large to be displayed in the current cell, it will be displayed as "#####". The formatting section of this manual explains how to widen a column.
*   **Text** consist mainly of alphabetic characters, but can also include numbers, punctuation marks and special characters (like the check mark in the example above). Text fields are not included in numeric calculations. If you want Excel to treat an apparent number as text, then you should precede the number with a single quotation mark ('). This can be useful when entering for example a phone number that starts with 0, since leading zeros are not usually displayed for Excel numbers.

If a text field is too long to be displayed in the current cell, it will spill over into the next cell if that cell is empty, otherwise it will be truncated at the cell border. The formatting section of this manual explains how to wrap text within a cell.

- **Formulas** are the most powerful elements of an Excel spreadsheet. Every formula starts with an "=" sign, and contains at least one logical or mathematical operation (or special function), combined with numbers and/or cell references.

9.2.3 Data entry cell by cell

To enter either numbers or text:
1. Click on the cell where you want the data to be stored, so that the cell becomes active.
2. Type the number or text.
3. Press [ENTER] to move to the next row, or [TAB] to move to the next column. Until you've pressed [ENTER] or [TAB], you can cancel the data entry by pressing [ESC].

To enter a date, use a slash or hyphen between the day, month and year, for example 14/02/2009. Use a colon between hours, minutes and seconds, for example 13:45:20.

9.2.4 Deleting data

You want to delete data that's already been entered in a worksheet? Simple!
1. Select the cell or cells containing data to be deleted.
2. Press the [DEL] key on your keyboard.
3. The cells remain in the same position as before, but their contents are deleted.

9.2.5 Moving data

You've already entered some data, and want to move it to a different area on the worksheet?
1. Select the cells you want to move (they will become highlighted).
2. Move the cursor to the border of the highlighted cells. When the cursor changes from a white cross to a four-headed arrow (the move pointer), hold down the left mouse button.

3. Drag the selected cells to a new area of the worksheet, then release the mouse button.

You can also cut the selected data using the ribbon icon or [CTRL] + [X], then click in the top left cell of the destination area and paste the data with the ribbon icon or [CTRL] + [V].

9.2.6 Copying data

To copy existing cell contents to another area on the worksheet:
1. Select the cells you want to copy (they will become highlighted).

2. Move the cursor to the border of the highlighted cells while holding down the [CTRL] key. When the cursor changes from a white cross to a hollow left-pointing arrow (the copy pointer), hold down the left mouse button.

3. Drag the selected cells to a second area of the worksheet, and then release the mouse button.

You can also copy the selected data using the ribbon icon or [CTRL] + [C], then click in the top left cell of the destination area and paste the data with the ribbon icon or [CTRL] + [V].

To copy the contents of one cell to a set of adjacent cells, select the initial cell and then move the cursor over the small square in the bottom right-hand corner (the fill handle).

The cursor will change from a white cross to a black cross. Hold down the mouse button and drag to a range of adjacent cells. The initial cell contents will be copied to the other cells.

Note that if the original cell contents end with a number, then the number will be incremented in the copied cells.

> If the original cell that you are moving or copying contains a reference to a cell address, then the copied cell address will be adjusted relative to the target cell. Refer to *Formulas – Referencing* later in this manual for details.

9.2.7 Using Autofill

This is one of Excel's niftiest features! It takes no effort at all to repeat a data series (such as the days of the week, months of the year, or a numbers series such as odd numbers) over a range of cells.

1. Enter the start of the series into a few adjacent cells (enough to show the underlying pattern).
2. Select the cells that contain series data.
3. Move the cursor over the small square in the bottom right-hand corner of the selection (the fill handle). Hold down the mouse button and drag to a range of adjacent cells.
4. The target cells will be filled based on the pattern of the original series cells.

9.2.8 Saving a workbook

So now it's time to save your work. As usual, you need to specify the file name, and its location (drive and folder).

1. Click the Office button and select Save, or click the Save icon on the Quick Access toolbar. If this workbook has been saved before, then that's it – your workbook will be saved again with the same name and location.

2. If it's the first time of saving this workbook, then the Save As dialogue box will open.
3. Click the drop-down arrow next to Save In to select the desired drive and folder.
4. Type the new file name in the File Name field.
5. Click the Save button.

> Every time you **Save** or **Save As** in Excel, the entire workbook is saved. This is another good reason for keeping related data on different worksheets in the same workbook! When you're working in the UCT computer labs, remember to save to the F: drive, so that you'll be able to access your work again later.

9.3 REFERENCES

Centre for Educational Technology, U. o. (2009). *Introduction to MS Excel 2007*. Retrieved Oct. 18, 2017, from https://vula.uct.ac.za/web/learnonline/manuals/CET%20MS%20Excel%202007%20Training%20Manual%20v1.1.pdf available under creative commons attribution license.

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UNIT 10: DATABASE MANAGEMENT SYSTEMS

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10.1 OBJECTIVES

After reading this unit the student will be able to:

1   Define Database concept.
2   Define architecture of a database system.
3   Understand principles of database.
4   Discuss normalization.
5   Understand structure query language.

10.2 INTRODUCTION

Data is one of the most important components in the information systems. In the early days data used to maintain using the traditional or manual record keeping system. This is also sometimes called as paper based record keeping system. However, there are some drawbacks in this manual record keeping system in terms of data handling and selection. In early days of 1960s the computer applications were developed directly on top of the file systems. Again there are some drawbacks on these file systems, such as multiple file formats and duplication of information in different files. After that it is realized that the purpose of any database is to meet the requirement of the users in terms of data storage, data access.

Now the database is a repository of a structured data to store its attributes in a proper way. Database Management System (DBMS) it is nothing but a computer-based record keeping system: that is, a system whose overall purpose is to record and maintain information. The information concerned can be anything that is deemed to be of significance to the organization the system is serving anything, in other words, that may be necessary to the decision-making processes involved in the management of that organization.

In this chapter we will discuss each one in rather detail.

10.3 DBMS

The *database management system* is the interface between the users (application programmers) and the database (the data). A database management system (DBMS) is a program that allows user to define, manipulate and process the data in a database, in order to produce meaningful information.

A DBMS is a set of *software programs* that controls the *organization, storage, management, and retrieval of data* in a database. It is a set of pre-written programs that are used to store, update and retrieve a database. The DBMS accepts requests for data from the application program and instructs the *operating system* to transfer the appropriate data. The followings are the examples of DBMS software :

Microsoft Visual FoxPro, MonetDB, MySQL , Oracle Database, PostgreSQL, SQL Anywhere, SQLite, FileMaker, IBM DB2, IBM UniVerse, Firebird, Microsoft Access, Microsoft SQL Server etc.

The following are examples of database applications:
   □ Reservation systems, banking systems
   □ Record/book keeping (corporate, university, medical), statistics
   □ Bioinformatics, e.g., gene databases

 ☐ Criminal justice, e.g. fingerprint matching
 ☐ Multimedia systems, e.g. image/audio/video retrieval
 ☐ Satellite imaging; require petabytes (10^{15} bytes) of storage
 ☐ The web
 ☐ Data mining (Knowledge Discovery in Databases) etc.

To complete our initial definitions, we will call the database and DBMS software together as a *database system*. The following figure depicts a database system.

A simplified database system
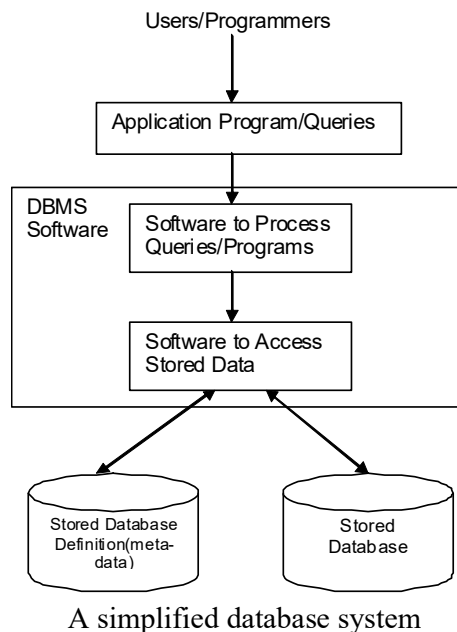
The purpose of the database system is:

Redundancy can be reduced – duplication of records in different database can be avoided by normalizing the database.

Inconsistency can be avoided – the data can be entered to represent a valid record with proper updating mechanisms without the duplication of records.

Data can be shared – the existing data can be shared and also the database also can be shared to develop new applications

Standards can be enforced – since data is centrally designed and maintained, all standards in the data are followed in the representation of data.

Security restrictions can be applied – the database can be enforced with authorization privileges to its users.

Integrity can be maintained – Number of rules and regulations can be applied on to the database for accurate data in the database.

Conflicting requirements can be balanced – the database can be structured to provide overall access to the organization.

Database systems offer convenient solutions to overcome the above problems. The system takes care of the data part from the design phase to selection phase for effectively maintaining the data of any organization.

10.4 ARCHITECTURE OF A DATABASE SYSTEM

The architecture is divided into three general levels:

1. Internal level
2. Conceptual level
3. External level

Internal level is the one closest to physical storage, that is, the one concerned with the way in which the data is actually stored.

Conceptual level describes the logical structure of an entire database, including descriptions of the data and relationships among the data.

External level is the users view to the database. Depending on their needs, different users access different parts of the database.
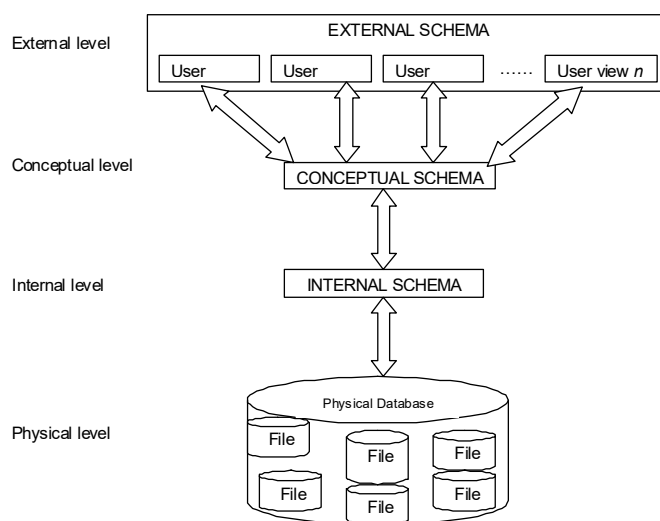
Three level view of Database architecture

10.5 TYPES OF DBMS

The modern business environment revolves around the accuracy and integrity of information. The advancements in computer technology and rapid development of graphical user interface (GUI)-based applications, networking and communications have resulted in new dimensions in database management systems. A DBMS can be classified according to the number of users, the database site locations and the type and extent of use.

On the basis of number of users :

☐ Single-user DBMS
☐ Multi-user DBMS

On the basis of site locations :

☐ Centralised DBMS
☐ Parallel DBMS
☐ Distributed DBMS
☐ Client/Server DBMS

On the basis of the type and extent of use

☐ Transactional DBMS

    ◻ Decision support DBMS
    ◻ Data Warehouse

10.5.1 Centralized DBMS

The centralized database system consists of a single computer system associated with its peripherals, physically located in a single location. The computer system offers data processing facilities to the users located either at the same site, or, at geographically dispersed sites, through remote terminals. The management of the system and its data are controlled centrally from any one or central site. The following figure shows a centralized database system.
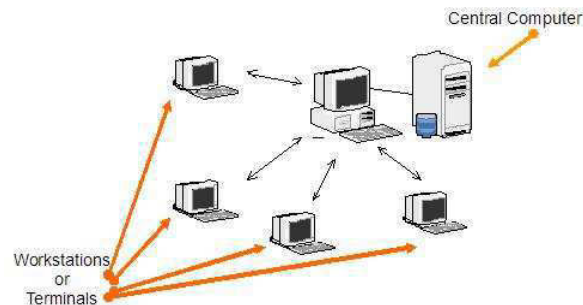
Centralized DBMS

Advantage of such system is given below:

◻Most of the functions such as update, backup, query, control access etc. are easier with this system.

◻Single database is shared across the several different users.

Of course, when the central site computer goes down, then every user is blocked from using the system until it recovers.

10.5.2 Parallel Database System

Parallel database systems architecture consists of a multiple central processing units (CPU) and data storage disk in parallel as shown in the figure. Hence, in such a system data processing speed is fast as well as input/output speed is also fast. The system, in which it needs to process an extremely large number of transactions per second, in such a system parallel database system is used.

Advantage of such sytem is given below :

◻Useful in the applications, which have to process an extremely large number of transactions per seconds (of the order of thousands of transactions per seconds)

◻Performance of such database system is very high.

The following figure shows a parallel database system.

Parallel database system
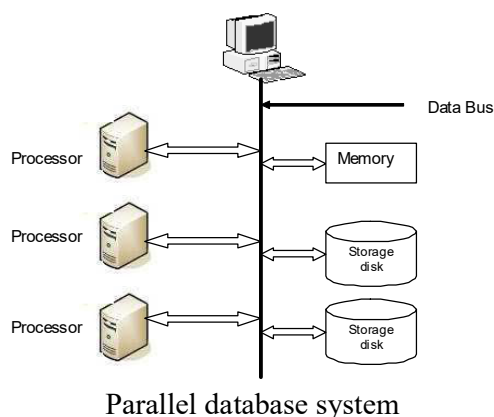
10.5.3 Distributed DBMS

In a distributed database system, data are spread across a variety of different databases. These are managed by a variety of different DBMS softwares running on a variety of different computing machines having different operating systems. These machines are actually located on different sites and connected with some kind of communication networks as shown in the figure below. Thus, in a distributed database system, the organizations data might be distributed on different computers in such a way that data for one portion (or department) of the organization is stored in one computer and data for another department is stored in another computer. Each machine can have own data and applications and users of one machine can access the data of several other computers.

The following figure shows a distributed database system.

Distributed database
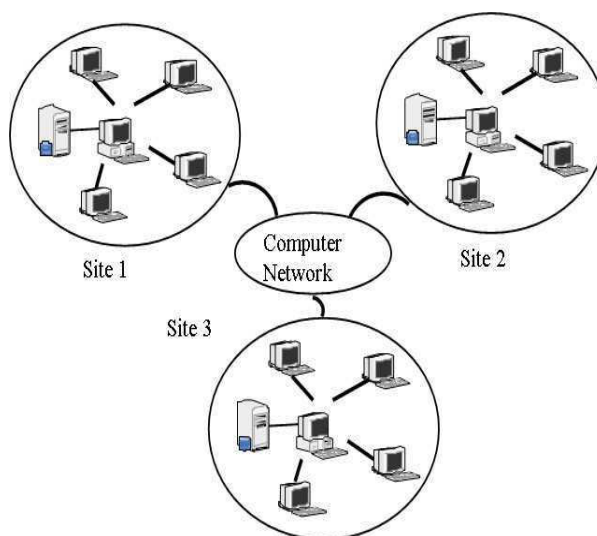
Advantage of such sytem is given below:

 Efficiency and performancce of this system is high.

 A single database can be shared across several distinct client systems.

 As data volumes and transaction rates increase, users can grow the system incrementally.

10.5.4 Client-Server DBMS

The client-server database system has two logical components namely - *client* and *server*. Clients are generally personal computers or workstations and the servers are the large workstations or mainframe computer system. The applications and tools of DBMS run on one or more client plateforms, while the DBMS softwares reside on the server. The server computer is called *backend* and the client computer is called *front-end*. The server and the clients are connected through networks. The clients send request to the server for performing some special tasks. The DBMS in the server side, in turn, process these requests and returns the results to the clients. The server handles parts of the job that are common to many clients, for example, database access and updates.

The following figure shows a client-server database model.
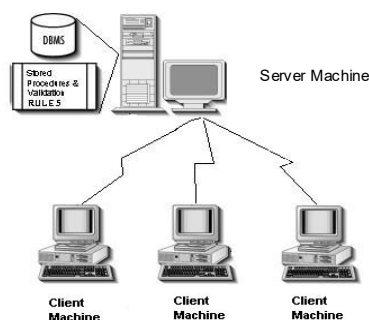
Fig. Client-Server database model

Advantage of such system is given below:

☐Performance is high.

☐A single database (on server) can be shared across several distinct client system.

☐More flexible as compared to the centralized system.

☐Facilitates in more productive work by the users and making better use of existing data.

10.6 DATA MODELS

Database model are designed to use one of database structures to provide simplistic access to information stored in databases. The main database structures are:

* Relational data model
* Network data model

10.6.1 Relational data model

This is the most widely used data base model that represents data as well as relationship among data in the form of tables. It looks like a file. Constraints are stored in a meta-data table. This is a very simple model and is based on a proven mathematical theory. Most relational data bases have high-level query languages and support a limited form of user views. Usually, the conceptual and internal schemas are not distinguishable, and a single Data Definition Language is used to describe all aspects of the database structure. Figure 4.2 shows the relational representation of student database.

Table: STUDENT

Name	Roll_No	Class	DOB
Raj	1	12	12/01/1990
Ramesh	2	12	103/04/1991

Relational representation of student data base

Advantages of Relational data model:

1. The relational data model can be implemented with a personal computer having limited main memory and processing capability.

2. Very effective for small databases.

3. Much easier to use because it enables a computer system to accommodate a variety of enquiries in an efficient manner.

4. Very easy to represent the logical relationship among the data items since it use primary key to represent record relationships instead of pointers.

5. Relational model is very useful for representing most of the real world objects and the relationships among them.

Disadvantages of Relational data model:

In this model, as the size of the database increases, several problems may come into existence – system slowdown, performance degradation and data corruption.

10.6.2 Network data model

In this model, data is represented as records and relationship as links. Figure 3.2 shows the network representation for the database STUDENT with grade, course and section. In the figure, record types are shown as rectangles and set types are shown as labeled directed arcs. The network model is also known as the Computer Data System Language Data Base Task Group (CODASYL DBTG) model. It has an associated record-at-a-time language that must be embedded in a host programming language.

Advantages of network model:

1. Useful to represent the records having many-to-many relationships.

2. Problem of inconsistency does not exist in this model because a data element is physically located at just one place.

3. Searching a record is easy since there are multiple access paths to a data element.

10.7 INTEGRITY CONSTRAINTS

The term *integrity* refers to the accuracy or correctness of data in the database schema and is expected to hold on every database instance of that schema. Relational model includes two general integrity constraints. They are:

10.7.1 Entity Integrity Constraints (Rule 1)

Entity Integrity Constraints states that no primary key value can be NULL. This is because we use the primary key value to identify individual tuples in a relation. It ensures that instances of the entities are distinguishable i.e., they must have a unique identification of some kind. Primary keys perform that unique identification function in a relational database.

10.7.2   Referential Integrity Constraints (Rule 2)

Referential Integrity Constraint is specified between two relations and is used to maintain the consistency among tuples of the two relations (not necessarily be distinct). It uses a concept of foreign key which will be explained more details in the next unit. Informally, it states that a tuple in one relation that refers to another relation must refer to an existing tuple in that relation. Considering the following relations,

EMPLOYEE

PRIMARY   FORIGN
KEY   KEY

ENO	ENAME	DNO
101	Robert	10
102	Smith	12
103	Robindra	12
104	John	10

DEPARMENT

PRIMARY
KEY

DNO	DNAME	LOCATION
10	**Comp. Sc.**	Jalukbari
12	**Electronic Sc.**	Guwahati

Relational database table showing referential integrity

In the above figure EMPLOYEE and DEPARTMENT are two relations where ENO and DNO are primary keys respectively. Here the attribute DNO of EMPLOYEE table is a foreign key that gives the department number for which each employee works. Hence its value in each EMPLOYEE tuple must match the DNO value of some tuple in the DEPARTMENT relation.

10.8 DOMAIN CONSTRAINTS

It specifies that each attribute in a relation must contain an atomic value only from the corresponding domains. The data types for commercial RDBMS domains are:

- Standard numeric data types for integer
- Real numbers
- Characters
- Fixed length and variable length strings

Thus, domain constraint specifies the condition that we want to put on each instance of the relation. So, the values that appear in each column must be drawn from the domain associated with that column.

10.9 THE CODD COMMANDMENTS

There are twelve (12) rules formulated by E.F. Codd for RDBMS in 1970 to define the requirements more rigorously within a single product. In reality it is true to say that they do not all carry the same degree of importance, but can be obtained a good result if an RDBMS satisfies all these twelve rules. The rules are:

Rule 1: The information rule

All information is explicitly and logically represented in exactly one way – by data values in tables. In simple terms this means that if an item of data does not reside somewhere in a table in the database then it does not exist and this should be extended to the point where even such information as table, view and column names to mention just a few, should be contained somewhere in table form.

Rule 2: The rule of guaranteed access

Every item of data must be logically addressable by resorting to a combination of table name, primary key value and column name. For a table like storage structure, this rule says that at the insertion of a column and row it is necessarily find one value of a data item or null.

Rule 3: Systematic treatment of null values

In DBMS NULL values are supported in the representation of missing and inapplicable information. This support for null values must be consistent throughout the DBMS and independent of all data type.

Rule 4: Database description rule

The description of the database is held and maintained using the same logical structures used to define the data, thus allowing users with appropriate authority to query such information in the same way and using the same languages as they would any other data in the database. It implies that there must be a data dictionary within the RDBMS that is constructed of tables and/or views that can be examined using SQL. Therefore a dictionary is mandatory for RDBMS.

Rule 5: Comprehensive sub-language rule

There must be at least one language whose statements can be expressed as character strings conforming to some well-defined syntax. In real terms, the RDBMS must be completely manageable through its own extension of SQL.

Rule 6: View updating rule

All views that can be defined using combination of base tables, and theoretically updatable, must also be capable of being updated by the system. This is quite a difficult rule to interpret and with all sorts of aggregates and virtual columns, it is obviously not possible to update through some of them.

Rule 7: Insert and update rule

An RDBMS do more than just be able to retrieve relational data sets. It has to be capable of inserting, updating and deleting data as a relational set.

Rule 8: Physical independence rule

User access to the database, via monitors and application programs, must remain logically consistent whenever changes to the storage representation, or access methods to the data, are changed. For example, if an index is built and destroyed by the DBA on a table, any user should still retrieve the same data from that table.

Rule 9: Logical data independence

Application programs must be independent of changes made to the base tables. This allows many types of database design change to be made dynamically, without users being aware of them.

Rule 10: Integrity rule

The relational model includes two general integrity rules which we have discussed in already in this unit. These integrity rule implicitly or explicitly define the set of consistent database states, or changes of state, or both. Other integrity constraints can be specified during database design.

Rule 11: Distribution rule

An RDBMS must have distribution independence. Thus, RDBMS package must make it possible for the database to be distributed across multiple computers even though they are having heterogeneous platforms both for hardware and operating system.

This is one of the most attractive aspects of RDBMSs, database system built on the relational framework are well suited to today's client/server database design.

Rule 12: No subversion rule

If an RDBMS supports a lower level language that permits for example, row at-a-time processing, then this language must not be able to bypass any integrity rules or constraints of the relational language.

10.10 KEYS

In a relational model, a database consists of relations (tables), which consists of tuples (or records/rows), which further consist of attributes (or fields/columns). We must have a way to specify how tuples within a relation are distinguished. Each relation in a relational database must have an attribute or combination of attributes such that they can uniquely identify the tuple. This unique identifier is called *key*. A key is that data item that exclusively identifies a record or tuple. It may consists of one or more attributes. We can split related data into different relations or tables and logically linked them together with the help of keys. Without this unique identifier, there is no way to retrieve the unique tuple from a relation.

For example, let us consider the following relation (table). In this unit we may use the terminologies *table*, *row* or *record* and *field* in place of *relation*, *tuple* and *attribute* respecively.

STUDENT

Roll_no	Name	Marks	Grade
1	Monirupa Misra	360	**A**
2	Ranjita Dutta	180	C
3	Rajib Sharma	310	A
4	Kaustab Baruah	265	B
5	Apurba Bora	310	A
6	Rajib Sharma	210	B

Table: Student

10.10.1 DIFFERENT TYPES OF KEYS

Every key which has the property of uniqueness can be distinguished as follows:
- Super Key
- Candidate Key
- Primary Key
- Alternate Key
- Composite Key
- Foreign Key

10.10.1.1 Super Key

A super key is a set of columns that uniquely identifies every row in a table. For example, if there is a table *STUDENT* with only two columns **Roll no** and *Name,* then the super key will be if we assume that there are no two student in the class with the same Roll no as well as Name.

{ Roll no, Name}

10.10.1.2 Candidate Key

A table can have more than one columns that could be chosen as the key because they individually have the capability to identify a record uniquely. These fields are termed as *candidate keys*. In other words, a candidate key is any set of one or more columns whose combined values are unique among all occurrences (i.e., tuples or rows or record). Since a NULL value is not guaranteed to be unique, no component of a candidate key is allowed to be NULL. Candidate keys are those attributes of a relation, which have the properties of *uniqueness* and *irreducibility*. These two properties are explained below:

Let K be a set of attributes of relation R. Then K is a candidate key for R if and only if it possesses both of the following properties:

Uniqueness: No legal value of R ever contains two distinct tuples with the same value for K.

Irreducibility: No proper subset of K has the uniqueness property.

Let us consider the following relation *EMP_INFO* containing some personal information of employees working in an office. Suppose all of them have passport.

EMP_INFO

Emp_ID	Name	Passport_no	Blood Group
12341	Kunal Kashyap	M 9523421	A+
12342	Rajib Sharma	M 9515212	O+
12343	Ankur Chakraborty	F 9515456	O+
12344	Niharika Bora	F 9643521	B+

Table: EMP_INFO

The attribute *Emp_ID* and *Passport no* possess unique data item for each employee. Therefore, any of these two attribute can be chosen as the key. These two are examples of *candidate keys* in the above relation. The attribute *Name* cannot be a candidate key as more

than one employee might have identical name. Similar, several employees might have same blood group. So **Blood Group** cannot be chosen as key.

10.10.1.3 Primary Key

Every database table should have one or more columns designated as the *primary key*. The value this key holds should be unique for each record in the database. In a database, there can be multiple candidate keys. Out of all the available candidate keys, a database designer can identify a primary key. The primary key should be chosen such that its attributes are never or very rarely changed.

A **primary key** is a field or combination of fields that uniquely identify a record in a table, so that an individual record can be located without confusion. Depending on its design, a table or relation may have arbitrarily many unique keys but at most one primary key. For example, let us assume we have a table called **EMPLOYEE_ADDRESS** that contains some information for every employee in an organization. We should need to select an appropriate primary key that would uniquely identify each employee. Our first thought might be to use the employee's name i.e, **Emp_Name**. But this would not work properly because two or more employees with the same name might be possible in the organization. The **Location** field of a person cannot be chosen as primary key since it is likely to change. A better choice might be to use a unique **Emp_ID** number that the organization assigns to each employee when they are appointed. **Emp_ID** can be a primary key as it does not changed till the person is working in the same organization.

EMPLOYEE_ADDRESS

Primary Key

Emp_ID	Emp_Name	Location
1231	Gautam Baruah	GS Road Guwahati
1232	Arindam Dutta	RG Barua Road
1233	Meghali Gogoi	Chandmari Guwahati
1235	Arindam Dutta	Guwahati

Table: EMPLOYEE_ADDRESS

In the table 10.1., student's **Roll_no** would be a good choice for a primary key in the **STUDENTS** table. The student's name would not be a good choice, as there is always the chance that more than one student with same name. Some other examples of primary keys are **Social Security Numbers** (associated with a specific person) , **ISBN_no** (associated with a specific book).

A primary key is a special case of unique keys. *Unique key constraint* is used to prevent the duplication of key values within the rows of a table and allow NULL values. Primary key allows each row in a table to be uniquely identified and ensures that no duplicate rows exist and no NULL values are entered. Thus **primary key constraint** can be defined as a rule that says that the primary key fields cannot be NULL and cannot contain duplicate data.

Once we decide upon a primary key and set it up in the database, the database management system (DBMS) will enforce the uniqueness of the key. If we try to insert a record into a table with a primary key that duplicates an existing record, the insert will fail. Sometimes, a table just does not have a primary key. In such cases, we may need to introduce an additional column which contains unique values. Most databases are also capable of generating their own primary keys. *Microsoft Access*, for example, may be configured to use the *AutoNumber* data type to assign a unique ID to each record in the table. While effective, this is a bad design practice because it leaves us with a meaningless value in each record in the table. It is better to use that space by storing some useful data.

Properties of Primary Key

To qualify as a primary key for an entity, an attribute must have the following properties:

Stable:

The value of a primary key must not change or should not become NULL throughout the file of an entity. A stable primary key helps to keep the model stable. For example, if we consider a patient record, the value for the primary key (*Patient number*) must not change with time as would happen with the age field.

Minimal:

The primary key should be composed of the minimum number of fields that ensures the occurrences are unique.

Definitive:

A value must exist for every record at creation time. Because an entity occurrence cannot be substantiated unless the primary key value also exists.

Accessible:

Anyone who wants to create, read or delete a record must be able to see the Primary key value.

10.10.1.4 Alternate Key

As we have seen, it is possible for a relation to have two or more candidate keys. If we chose any one of them as primary key, then the remaining keys will be termerd as alternate key. The alternate key (or secondary key) is any candidate key which is not selected to be the primary key. For the illustration of alternate key, let us consider the following table ELEMENT which stores some information like element name, symbol, atomic number of the elements of periodic table.

ELEMENT

Name	Symbol	Atomic_no
Hydrogen	H	1
Helium	He	2
Lithium	Li	3
Berylium	Be	4

Table: ELEMENT

All the three fields can individually identify each element in the table. So any of these three fields can be chosen as the primary key . If we choose **Symbol** as the primary key; **Name** and

Atomic_no would then be alternate keys. Similarly, in the *EMP_INFO* (table 10.3), if we consider *Emp_ID* as the primary key then *Passport_no* will be the alternate key.

10.10.1.5 Composite Key

In some situations, while designing a database, there may not be a particular column or field that can individually identify a record uniquely in a table. In such cases, we may require to select two or more fields so that combination of those can identify each record uniquely. These combination of fields is known as *composite key*. It is used when a record cannot be uniquely identified by a single field.

For the illustration of composite key, let us consider the following table *ITEM* with the fields *Supplier_ID, Item_ID, Item_Name* and *Quantity*. This table gives us the information which supplier sells which item. As we can see, any of these fields indivisually cannot identify a row in the table uniquely. But if we combine *Supplier_ID* and *Item_ID*, then these together can easily identify any row in the table uniquely. Thus, *Supplier_ID* and *Item_ID* together becomes a composite key.

ITEM

Supplier_ID	Item_ID	Item_Name	Quantity
S_1	I_1	AC	5
S_1	I_2	Inverter	8
S_2	I_2	Inverter	4
S_2	I_3	UPS	15

Table: ITEM

10.10.1.6 Foreign Keys

One important type of key that we will discuss in this unit is the *foreign key*. These keys are used to create relationships between tables.

A foreign key is a field in a relational table that matches the primary key column of another table. It identifies a column or a set of columns in one (referencing) table that refers to a column or set of columns in another (referenced) table. The columns in the referencing table must be the primary key or other candidate key in the referenced table. The values in one row of the referencing columns must occur in a single row in the referenced table. Thus, a row in the referencing table cannot contain values that do not exist in the referenced table. This way references can be made to link information together and it is an essential part of database normalization. Multiple rows in the referencing table may refer to the same row in the referenced table.

For example in an employee's database, let us imagine that we wanted to add a table *DEPARTMENT* containing departmental information to the database. We would also want to include information about the employees in the department, but it would be redundant to have the same information in two tables (*EMPLOYEE* and *DEPARTMENT*). Instead, we can create a relationship between the two tables. Let us assume that the *DEPARTMENT* table uses the *Department Name* column as the primary key. To create a relationship

between the two tables, we add a new column to the *EMPLOYEE* table called *Department Name*. We then fill in the name of the department to which each employee belongs. The *Department Name* column in the *EMPLOYEE* table is a *foreign key (FK)* that references the *DEPARTMENT* table. The database will then enforce *referential integrity* by ensuring that all of the values in the *Department* column of the *EMPLOYEES* table have corresponding entries in the *DEPARTMENT* table.

EMPLOYEE

PK   FK

Name	Post	Department_Name
Goutam Bora	Accountant	Sales
Manash Saikia	Manager	Marketing
Himangshu Das	Financial Officer	Human Resource
Niharika Baruah	Accountant	Production
Pranjal Hazarika	Law Officer Human Resource	Human Resource

Table: EMPLOYEE

DEPARTMENT

PK

Department_Name	Manager	Dept_Code
Human Resource	Manash Saikia	D1
Marketing	Dhruba Sharma	D2
Production	Diganata Bora	D3

Table: DEPARTMENT

Again, let us consider a book database. The *BOOKS* table has a link to the *PUBLISHERS* table. The *Pub_ID* column is the primary key for the *PUBLISHERS* table and *ISBN_no* is the primary key for the *BOOKS* table. The *BOOKS* table also contains a *Pub_ID* column which matches the primary key column of the *PUBLISHERS* table. This *Pub_ID* is the foreign key in the *BOOKS* table. The *Pub_ID* field in the *BOOKS* table indicates which publisher a book belongs to.

PUBLISHERS

PK

Pub_ID	Pub_Name	City	State

Table: PUBLISHERS

BOOKS

PK   FK

ISBN_no	Book_name	Author_name	Pub_ID	Pub_date	Price

Table: BOOKS

Although the primary purpose of a *foreign key constraint* is to control the data that can be stored in the foreign key table, it also controls changes to data in the primary key table. For example, if the row for a publisher is deleted from the *PUBLISHERS* table, and the

publisher's ID is used for books in the ***BOOKS*** table, the relational integrity between the two tables is broken; the deleted publisher's books are orphaned in the ***BOOKS*** table without a link to the data in the ***PUBLISHERS*** table. A foreign key constraint prevents this situation. The constraint enforces referential integrity by ensuring that changes cannot be made to data in the primary key table if those changes invalidate the link to data in the foreign key table. If an attempt is made to delete the row in a primary key table or to change a primary key value, the action will fail if the deleted or changed primary key value corresponds to a value in the foriegn key constraint of another table. To change or delete a row in a foreign key constraint successfully, we must first either delete the foreign key data in the foreign key table or change the foreign key data in the foreign key table, thereby linking the foreign key to different primary key data. i.e., a primary key constraint cannot be deleted if referenced by a foreign key constraint in another table; the foreign key constraint must be deleted first.

10.11 NORMAL FORMS

Whenever the simple rules of functional dependencies are applied to a relations, it transforms the relations into a state which called *normal form.* The normal forms are used to ensure that various types of anomalies and inconsistencies are not introduced into the database. Various types of normal forms are used in relational data base, they are :
  ☐ First normal form (1 NF)
  ☐ Second normal form (2 NF)
  ☐ Third normal form (3 NF)

10.11.1 First Normal Form (1NF)

A relation is said to be in first normal form if the values in the domain of each attribute of the relation are atomic. The first normal form prohibits multivalued attributes, composite attributes and their combinations. It means that, 1NF disallows having a set of values, a tuple of values, or combination of both as an attribute value for a single tuple.
Let us consider the relation TRAVEL_INFO as shown in the figure.

```
PERSON                    VISITED_CITY
HEMANGA        CITY            JOURNEY_DATE
               DELHI           04-07-02
               MUMBAI          15-09-03
               AGRA            02-03-04
BIKASH         CITY            JOURNEY_DATE
               CHENNAI         05-01-02
               KOLKATA         13-02-03
               PUNE            21-08-04
               Un-normalized relation TRAVEL_INFO
```

Here, in the relation the domain VISITED_CITY is not simple. Hence, the relation is un-normalized. Now, let us combine the respective rows in VISITED_CITY with the value of the attribue PERSON and the resultant relation is shown below -

PERSON	CITY	JOURNEY_DATE
HEMANGA	DELHI	04-07-02
HEMANGA	MUMBAI	15-09-03
HEMANGA	AGRA	02-03-04
BIKASH	CHENNAI	05-01-02
BIKASH	KOLKATA	13-02-03
BIKASH	PUNE	21-08-04

Table Modified relation TRAVEL_INFO

Let us consider another relation PATIENT_DOCTOR, which keeps the records of appointment details bhetween patient and doctors. This relation is in 1NF. The relational table can be depicted as -

PATIENT_DOCTOR (P_NAME, DOB, D_NAME, DATE_TIME, PHONE, DURATION)

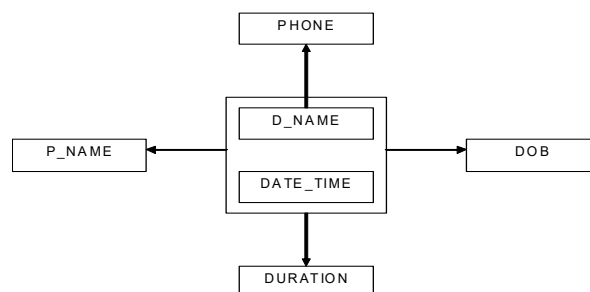| P_NAME	DOB	D_NAME	PHONE	DATE_TIME	DURATION
MUKUL	10-02-1975	Dr Deepak	0361-223470	10-01-05 10:00	15 (minutes)
RUHIT	27-01-1971	Dr Kalyan	0361-270512	10-01-05 11:00	10
JAMES	30-03-1977	Dr Dhiraj	0361-270615	10-01-05 10:30	10
JAMES	30-03-1977	Dr Dhiraj	0361-270615	10-01-05 09:00	10
RUHIT	27-01-1971	Dr Kalyan	0361-223470	10-01-05 10:15	15
MUKUL	10-02-1975	Dr Dhiraj	0361-270615	10-01-05 10:50	20
RANA	02-11-1980	Dr Kalyan	0361-270512	10-01-05 11:10	20
MUKUL	10-02-1975	Dr Deepak	0361-223470	06-02-05 16:00	15

Table Relation PATIENT_DOCTOR

From the relational table we have observed that a doctor cannot have two simultaneous appointments so D_NAME and DATE_TIME is a compolsite key. Similarly, a patient cannot have same time from two different doctors. Therefore, P_NAME and DATE_TIME attributes are also a candidate key.

Problems in 1 NF :

1 NF contains redundant information. In our example, PATIENT_DOCTOR relation has the following errors :

a)There exists redundant information in patients date of birth and phone number.

b)A doctor, who does not currently have an appointment with a patient, cannot be represented.

c)A patient, who does not currently have an appointment with a doctor, cannot be represented.

FDD of relation PATIENT_DOCTOR

Functional dependency diagram of the relation PATIENT_DOCTOR is shown. Here, P_NAME, DURATION, DOB are dependent on the key D_NAME & DATE_TIME and doctor's contact number i.e. PHONE is only dependent on the D_NAME.

10.11.2 Second Normal Form (2NF)

A relation or table is said to be in second normal form (2NF) if and only if -

a)it is in 1NF,

b)each non-primary key attribute is fully functionally dependent on primary key of that relation.

2NF is an intermediate step towards higher normal forms. 2NF is based on the concept of *full functional dependency*. It eliminates the problems of 1NF.

So, we come to know that, no attributes of the relation (or table) should be functionally dependent on only one part of a concatenated primary key. In our example, we have seen from the functional dependancy diagram that, PHONE is partiallly dependent only on D_NAME, for which the relation is not in 2NF.

Therefore, to bring the relation into 2NF, the information about doctor and their contact numbers have to be separated from information about patient and their appointments with doctors. Thus, the relation is decomposed into two tables, namely PATIENT_DOCTOR and DOCTOR as shown below. The relational table can be depicted as :

PATIENT_DOCTOR (P_NAME, DOB, D_NAME, DATE_TIME, DURATION)
**DOCTOR** (D_NAME, PHONE)

P_NAME	DOB	D_NAME	DATE_TIME	DURATION
MUKUL	10-02-1975	Dr Deepak	10-01-05 10:00	15 (minutes)
RUHIT	27-01-1971	Dr Kalyan	10-01-05 11:00	10
JAMES	30-03-1977	Dr Dhiraj	10-01-05 10:30	10
JAMES	30-03-1977	Dr Dhiraj	10-01-05 09:00	10
RUHIT	27-01-1971	Dr Kalyan	10-01-05 10:15	15
MUKUL	10-02-1975	Dr Dhiraj	10-01-05 10:50	20
RANA	02-11-1980	Dr Kalyan	10-01-05 11:10	20
MUKUL	10-02-1975	Dr Deepak	06-02-05 16:00	15

Table 10.4 Relation PATIENT_DOCTOR

D_NAME	PHONE
Dr Deepak	038-223-76
Dr Karan	038-2708-1
Dr Oraj	038-2708-5
Dr Oraj	038-2708-5
Dr Karan	038-223-76
Dr Oraj	038-2708-5
Dr Karan	038-2703-1
Dr Deepak	038-223-76

Table 10.5 Relation DOCTOR

The functional dependency diagram of the above two relations are shown below :
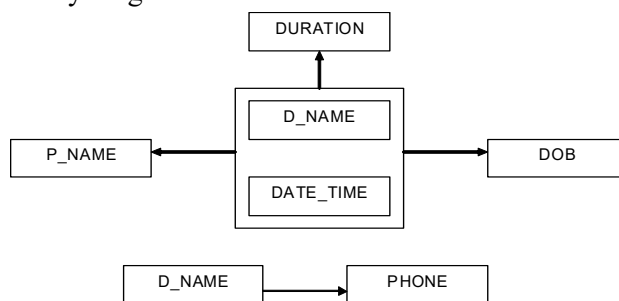
FFD of relation PATIENT_DOCTOR

10.11.3 Third Normal Form (3NF)

A relation or table is said to be in third normal form (3NF) if the relation is in 2NF and the non-prime attributes are -

a)mutually independent,

b)functionally dependent on the primary key.

It means that, no attributes of the relation should be transitively functionally dependent on the primary key. Thus, in 3NF, no non-prime attribue is functionally dependent on another non-prime attribute. This means that *a relation in 3NF consists of the primary key and a set of independent nonprime attributes*. 3NF is based on the problem of transitive dependency. The 3NF eliminates the problem of 2NF.

In our example, in the Fig 8.5, relation PATIENT_DOCTOR , there is no dependency between the attributes P_NAME and DURATION. Again, P_NAME and DOB are mutually dependent. So, the relation is not in 3NF.

To bring the relation into 3NF, it has to be decomposed and remove the attributes that are not directly dependent on the primary key. Now, using the *transitive dependency,* DOB can be linked to the primary key, through its dependency on the P_NAME. The functional dependency diagram is shown below. Now, the relations uses are -

PATIENT_DOCTOR(P_NAME,D_NAME, DATE_TIME,DURATION)
DOCTOR (D_NAME, PHONE)
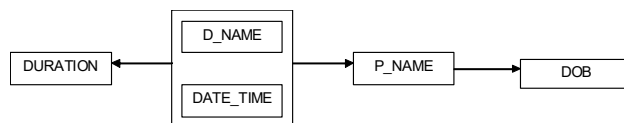**PATIENT** (P_NAME, DOB)

Fig. FDD for relation PATIENT_DOCTOR

Now, let us consider an another relation namely STUDENT.

STUDENT (Roll_No, Name, Dept, Year, Hostel_Name)

Roll_No	Name	Dept	Year	Hostel_Name
1784	Ruhit	Physics	1	Ganga
1648	Keshab	Chemistry	1	Ganga
1768	Gopal	Maths	2	Kaveri
1848	Raja	Botany	2	Kaveri
1682	Mrinal	Geology	3	Krishna
1485	Sumit	Zology	4	Godavari

Table STUDENT relation

Here, the dependency Roll_No -> Hostal_Name is transitive through the following two dependencies :

Roll_No -> Year,

Year -> Hostal_Name

Thus, the STUDENT relation is not in 3NF. To bring the relation into 3NF we can decompose the relation into two relation STUD1 and STUD2, as shown below.

STUD1 (Roll_No, Name, Dept)

STUD2 (Year, Hostel_Name)

Roll_No	Name	Dept	Year
1784	Ruhit	Physics	1
1648	Keshab	Chemistry	1
1768	Gopal	Maths	2
1848	Raja	Botany	2
1682	Mrinal	Geology	3
1485	Sumit	Zology	4

Table Relation STUD1

| Year	Hostel_Name
1	Ganga
1	Ganga
2	Kaveri
2	Kaveri
3	Krishna
4	Godavari

Table Relation STUD2

In the above examples, the conversion into 3NF is not hard, but when-ever a relation has more than one combination of attributes that may be considered as primary key then the conversion becomes proble-matic. Let us consider the following relation UTILIZE, shown below.

Project	Proj_Manager	Machine	Qty_Used
P1	Thomas	Excavator	5
P3	John	Shovel	2
P2	Abhishek	Drilling	5
P4	Avinash	Dumper	10
P3	John	Welding	3
P1	Thomas	Drilling	4

Table Relation UTILIZE

The relation stores the machines information used by both projects and project managers. Each project has one prooject manager and each project manager manages one project. Now it is obvious from the table that , we can consider any one of the combination of attributes as primary key, namely, {Project, Machine} or {Proj_Manager, Machine}. The FDD for relation UTILIZE is shown below.
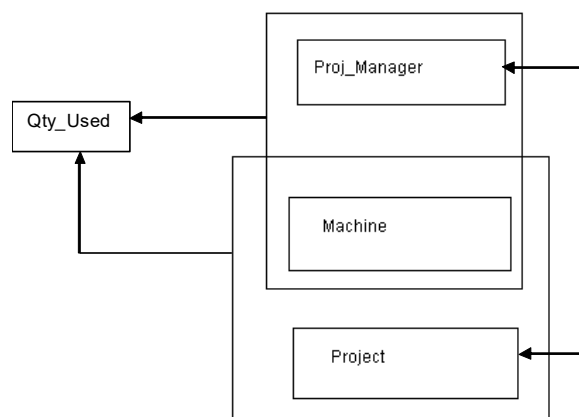
FDD of UTILIZE

In the relation, there is only one non-prime attribute called, QTY_Used, which is fully functionally dependent on each of the two relations. Thus, the relation UTILIZE is in 2NF. Moreover, there is only one non-prime attribute Qty_Used, there can be no dependencies between non-prime attributes. Thus the relation is also in 3NF.

Problems in 3NF :

If we consider the above relation i.e. UTILIZE, which is in 3NF, has the following undesirable properties :

a)the project manager of each project is stored more than   once.

b)A project manager cannot be stored until the project has ordered some machines

c)A project cannot be entered unless that project's manager is known.

d)If a project's manager changes, some rows also must be changed.

10.12 SQL

The following are the important features of SQL:

i)SQL can be used by a range of users, including those with little or no programming experience.

ii)It is non procedural language.

iii)It reduces the amount of time required for creating and maintaining systems.

iv)It is an English-like language.

10.12.1 CLASSIFICATION OF SQL STATEMENTS

SQL statements are classified into three categories. They are–

Data Definition Language (DDL)

Data Manipulation Language (DML)

Data Control Language (DCL)

Data Definition Language

With the help of DDL statements, you can create and alter database objects like Tables, Rules etc like Create Table, Drop Table, and Alter Table. We will examine these in a next section of this unit.

Data Manipulation Language

DML statements enable you to change data and retrieve information from tables like Select, Insert, Update and Delete.

Data Control Language

DCL statements allow you to set, change permissions for security purposes like Grant, Deny and Revoke.

In order to apply SQL statements, you have to learn SQL syntax. For example, to create a database and a table, you have to apply the syntax for creating the same. For each and every purpose of database operations there are syntaxes.

10.12.2 SQL QUERY

Basically, all SQL code is written in the form of a query statement. All SQL queries perform some type of data operation such as selecting data, inserting/updating data, or creating data objects such as SQL databases and SQL tables. Each query statement begins with a clause. Structurally, each SQL query is similar.

SQL *Expressions* are the pieces of a SQL query that compare values against other values or perform arithmetic calculations. Expressions can be found inside of any SQL command usually in the form of a conditional statement. In the SQL world, conditional statements and expressions test or compare values against other values. Boolean expressions return rows (results) when a single value is matched with other values. SQL also offers several built-in functions to perform what is known as aggregate data calculations against a table or a specific table column. For Example following functions executed with query processing statements

AVG() — Returns the average value of a stated column.

COUNT(*) — Returns a count of the number of rows of table.

SUM() — Returns the sum of a given column

Syntax, by definition, means the study of linguistic rules and patterns. Every programming language, including SQL, must follow a unique set of guidelines termed syntax. Punctuation, spaces, mathematical operators, and special characters have special meaning when used inside of SQL commands and query statements.

By using the following rules, you can construct valid SQL statements that are both easy to read and edit.

· SQL statements are not case sensitive.

·SQL statements can be on one or more lines.

·Keywords cannot be abbreviated or split across lines.

·Clauses are usually place on separate lines.

·Tabs and indents are used to enhance readability.

·Keywords (i.e. CREATE, ALTER …etc) are generally entered in the upper case.

·Only one statement can be current at any time within the buffer, and it can be run in continuous line by placing a semicolon (;) at the end of last clause.

10.13 SUGGESTED READINGS

1. *"Database Systems:Concepts, Design and Applications",* by   S.K.Singth, Pearson Education

2. "Introduction to Database Management Systems", by Atul Kahate, Pearson Education

3. *"Fundamentals of Database Systems",* by Elmasri Navathe, Somayajulu & Gupta , Pearson Education Publication.

4. *"An Introduction to Database Systems*, by C.J. Date, Eighth   Edition, Addison Wesley, 2003.

10.14 TERMINAL QUESTIONS

- What do you mean by DBMS?
- Write DBMS Database Structure Name.
- What is SQL?
- What is the different between Primary keys and foreign key?